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Scientific note

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Things are not always as they seem: High-resolution X-ray CT scanning reveals the first resin-embedded miniature gecko of the genus *Ebenavia*

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Abstract. We identify a presumed specimen of *Sphaerodactylus* in amber from the Zoological Research Museum Alexander Koenig as being embedded in copal, rather than amber. Further, the specimen matches the morphology not of a Hispaniolan gecko, but of the extant Madagascan species *Ebenavia boettgeri*, which occurs in a known area of copal deposits.

Key words. *Sphaerodactylus*, *Ebenavia*, CT scan, Madagascar, Osteology.

Fossil lizards embedded in amber are frequently spectacular since they preserve, in high definition, the three dimensionality of ancient organisms. To date, fossil remains of squamates have been found in six amber deposits around the world (Daza et al., 2016). Examples include the oldest reptile in amber (*Baabdasaurus xenurus*) from the Early Cretaceous of Lebanon (Arnold et al., 2002); some scales attributable to a squamate from the Albian of France (Perrichot and Néraudeau, 2005); 14 fossil squamates from the mid-Cretaceous of Myanmar, including members with affinities to Iguania, Gekkota, Scincoidea, Anguimorpha, and Ophidia (Arnold & Poinar, 2008; Daza et al., 2016; Fontanarrosa et al., 2018; Daza et al., in press; Xing et al., 2018); a gekkotan and numerous lacertids in Baltic amber (*Succinilacerta succinea*, Böhme & Weitschat, 1998; Borsuk-Białynicka et al., 1999; *Yantarogekko balticus*, Bauer et al., 2005; see also Černaňský & Augé, 2013); and many lizards from the Miocene deposits of Mexico and Hispaniola classified in the genus *Anolis* (*A. electrum*, Lazell, 1965; Rieppel, 1980; de Queiroz et al., 1998; Polcyn et al., 2002; Castañeda et al., 2014; Sherratt et al., 2015) and *Sphaerodactylus* (*S. dommeli*, Böhme, 1984; *S. ciguapa*, Daza & Bauer, 2012). Copal specimens have received relatively less attention and were reviewed in Broschinski & Kohring (1998). The genera *Phelsuma*, *Lygodactylus*, and *Geckolepis* have been preserved in Madagascan copal.

The study of lizards in amber has been facilitated by the use of X-rays and High-Resolution X-ray computed tomography (HRCT; Polcyn et al., 2002; Daza et al., 2013; Castañeda et al., 2014; Sherratt et al., 2015; Daza et al., 2016), allowing the rendering of the skeleton without distortion, in addition to providing incredible integumentary detail. As part of an ongoing research project, we examined all available gecko specimens in Miocene amber from Hispaniola preserved in amber using HRCT. One specimen was revealed to be neither a *Sphaerodactylus* nor embedded in Miocene amber. The specimen was scanned at the Center for Nanoscale Systems, Harvard University using a Nikon (Metris) X-Tek HMXST 225 scanner with a molybdenum target at 70kV, 135 µA, 1000 ms exposure, 3143 projections, 0.1° rotation step, and no filter. The reconstructed voxel size for the particular specimen was 14.251 µm. The original data set has been archived and is available to the public at Morphosource (https://www.morphosource.org/Detail/ProjectDetail/Show/project_id/545). Additional specimens for comparison were scanned at UTCT | The University of Texas High-Resolution CT Facility in a Xradia – Zeiss machine. The specimens were scanned with a 4X objective,

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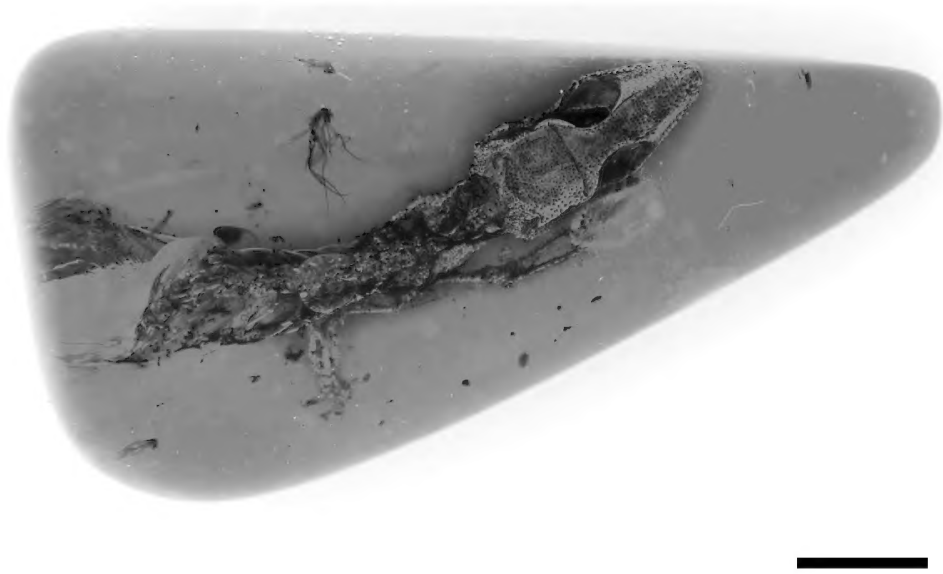

Fig. 1. Specimen ZFMK 94000, in dorsal view. Scale bar equals 5 mm.

70kV/10W using variable parameters. These specimens are part of a large data base of skull Micro-CT that includes nearly all gekkotan genera (Aaron M. Bauer digital collection). All post- processing of the scan data was performed using Avizo Lite 9.5.0 (©FEI SAS, Thermo Fisher Scientific, 2018).

The specimen in question, from the Alexander Koenig Research Museum (ZFMK 94000, Fig. 1), had been obtained by the museum sponsoring society (Alexander-Koenig-Gesellschaft) in November 2012 under the assumption that it was a piece of Dominican amber with a *Sphaerodactylus* (Gekkota: Sphaerodactylidae) inclusion. Although the size and overall appearance is consistent with that of these miniaturized geckos (Daza et al. 2008), a more thorough analysis of this material and comparison with the Micro-CT data base of gekkotans indicated that this specimen is a Madagascan clawless gecko of the genus *Ebenavia* in the family Gekkonidae. Morphological data indicates that the specimen is a subfossil, and that the resin is copal, not amber.

Copal from Madagascar is botanically assigned to the fabacean species *Hymenaea verrucosa* (Penney et al., 2005). Copal can be differentiated from mature resins, such as amber, with Raman spectroscopic analyses, showing more intense bands at around 1640 cm^{-1} due to more stretching vibrations of the v(C=C) attributed to the olefinic group (C=CH2; Winkler et al., 2001). Thermal analyses have also been used to characterize resins; copal from Madagascar may be differentiated from amber and other copal resins in reaching a peak in differential thermogravimetric analysis at 384 °C, while Colombian copal and amber from other localities peaks at 400 °C or more (Ragazzi et al., 2003). The age of copal resins may be only a few hundred to up to four million years old. Some resins from Madagascar have been dated using carbon dating analyses to be as young as just a few decades (Poinar, 1999; Bosselaers et al., 2010). Other estimates

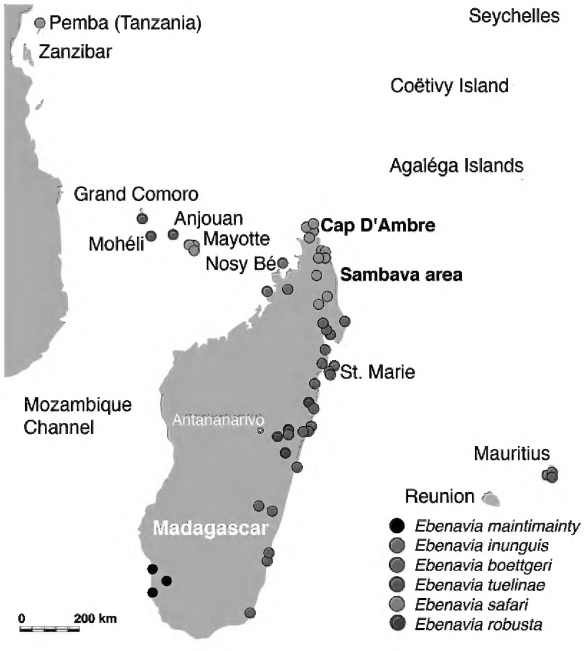

Fig. 2. Distributional map of *Ebenavia* species. Colors follow Hawlitschek et al. (2018). Additional localities for *E. maintimainty* taken from Nussbaum and Raxworthy (1998).

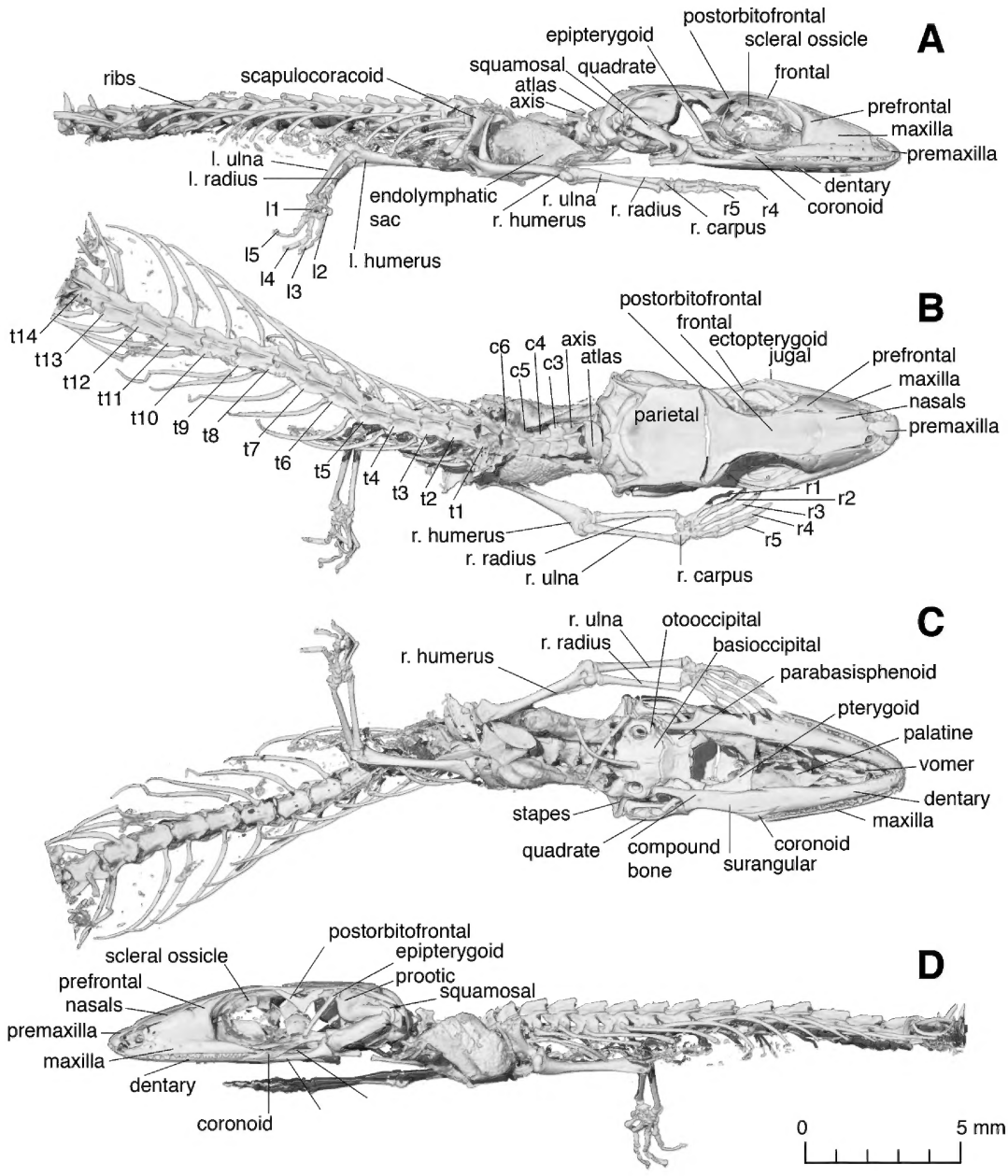

Fig. 3. Gecko in copal (*Ebenavia boettgeri*, ZFMK 94000) **A.** right lateral view, **B.** dorsal view; **C.** ventral view; **D.** left lateral view indicating the major bones. Abbreviations c#, cervical vertebrae #, l#, left toe #, r#, right toe #, t#, thoracic vertebrae #.

for the age of Madagascan copal include a range from Holocene to Recent (10,000–100 y; Schlüter & Gnielinski, 1987; Lourenço, 1996; Winkler et al., 2001). In this study, we confirmed that the specimen is embedded in copal based on the morphological similarities with modern species, and some simple tests on the resin: 1) A hot needle was pushed into the piece, causing rapid melting at the point of insertion (rather than slow melting expected in amber); the melting resin released a mild fragrance (amber yields a sooty odor). 2) Under a UV lamp the piece did not show any color change (rather than emitting a bluish glow, as does amber).

Morphological comparisons considering members of nearly all described gekkotan genera indicate that *Ebenavia* shares most morphological characters with ZFMK 94000. The genus occurs on Madagascar and satellite islands, Pemba Island, Grand Comoro, Mohéli, Anjouan, Mayote, Nosy Bé, Nosy Komba, Île Sainte-Ma-

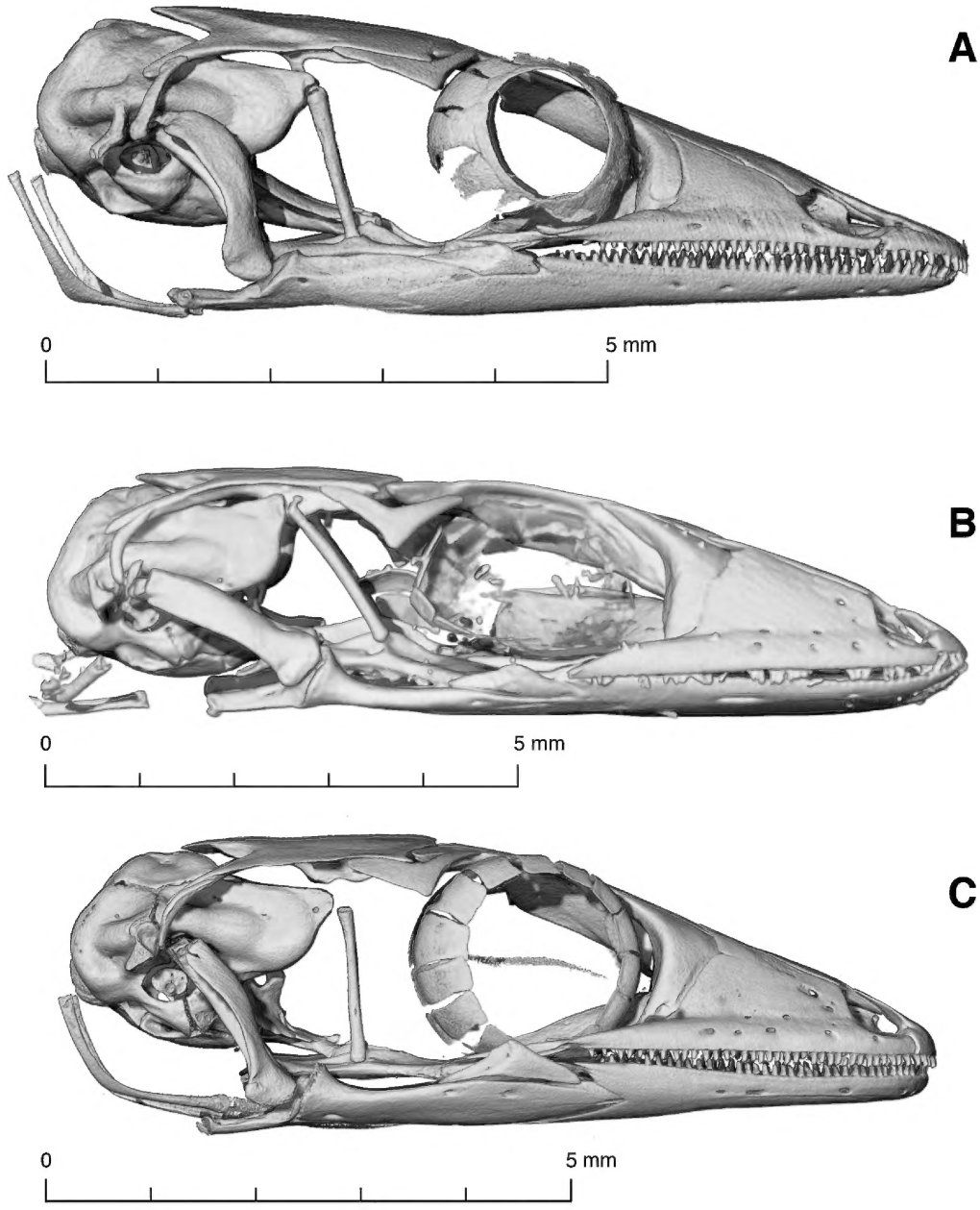

Fig. 4. HRCT of the skulls of three geckos. Sphaerodactylidae: **A.** *Sphaerodactylus semasiops* (MCZ R-55766); Gekkonidae: **B.** *Ebenavia boettgeri* (ZFMK 94000), and **C.** *Ebenavia boettgeri* (CAS 66195).

rie (Nosy Boraha), Nosy Mangabe, and Île aux Prunes (Nosy Alañaña), as well as Mauritius (Ramanamanjato et al., 2002; Hawlitschek et al., 2017, 2018; Uetz et al., 2018). Until recently *Ebenavia* included only two species (*E. maintimainty* and *E. inunguis*). *Ebenavia maintimainty* has a restricted range, being found in Toliara Province in southwestern Madagascar (Nussbaum & Raxworthy, 1998), while the more widespread *E. inunguis* was recently split into four new species (viz., *E. boettgeri*, *E. robusta, E. safari, E. tuelinae*; Hawlitschek et al., 2018, Fig. 2). Copal deposits in Madagascar are concentrated in the northern part of the island (i.e., Cap D'Ambre and the Sava Region, Geirnaert 2002), which is compatible with the distribution of *E. safari* and *E. boettgeri* (Hawlitschek et al., 2018).

The specimen is embedded in a cone-shaped piece of orange resin (Fig. 1). The preservation is exceptional, conserving the complete anterior half of the body. It ap-

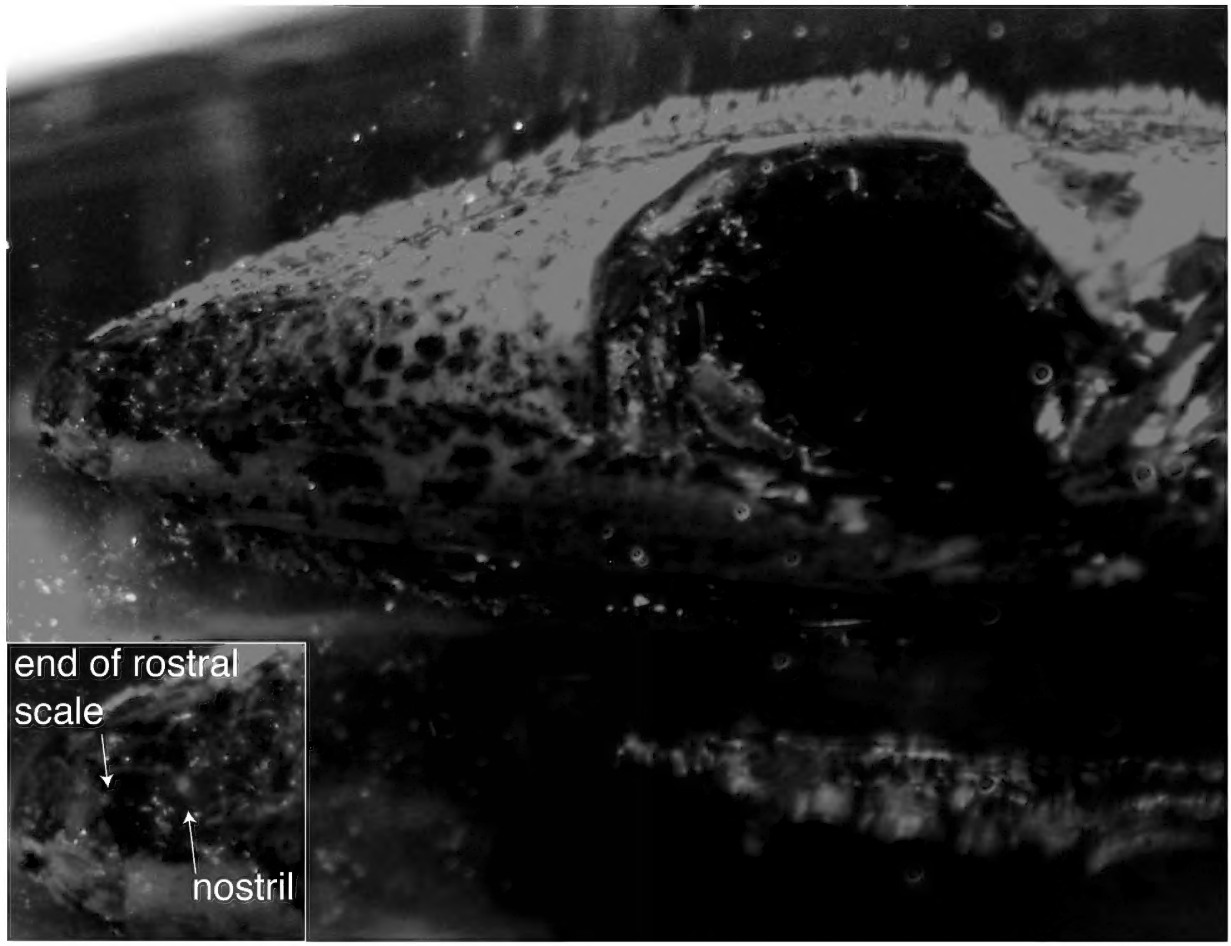

Fig. 5. Lateral view of the snout of ZFMK 94000, inset shows the separation between the rostral scale and the nostril.

pears desiccated, but the skeleton is in perfect condition, including the skull, vertebral column (all six cervical and 14 thoracic vertebrae), ribs, pectoral girdle and forelimbs (Figs 1, 3). The skull is intact, with the exception of the anterior portion of the left maxillary bone, which appears damaged, and both sclerotic rings, which are collapsed. Even fine details of the skeleton are visible (e.g., small sesamoids in the elbow; Fig. 3). Although having an intact skeleton is not necessarily an indication of its young geological age (for example, a Mesozoic gecko in amber exhibits a near pristine skeleton, Daza et al., 2016), the skeleton typically exhibits multiple fractures in the majority of Miocene *Sphaerodactylus* from Hispaniola. Using two X-rays from three ethanol preserved specimens of *Ebenavia boettgeri* (CAS 66195 [male, based on the presence of cloacal bones], CAS 66196 [gravid female with 2 eggs], 16° 54' 37.08" S, 49° 54' 40.716" E, St. Marie, and USNM 495825 25° 01' 12.0" S, 46° 58' 48.0" E [gravid female with 1 egg]) we were able to determine that the missing portion of the precloacal region (SVL) is between 18 and 25% of the SVL. Using these values, the estimated SVL of the copal specimen is 34.8–37.8 mm. The estimated size matches several species of *Ebenavia,* although it greatly exceeds the adult size range of *E. maintimainty* (21–24 mm; Nussbaum & Raxworthy, 1998).

The specimen in copal was compared to similarly sized, formalin-fixed, ethanol preserved specimens of *E. boettgeri* from St. Marie (Fig. 4) and *E. robusta* (ZSM296/2010; Hawlitschek et al., 2018). Shared traits with *Ebenavia* include a small premaxilla with a short ascending nasal process (long in *Sphaerodactylus*); fused nasals (unfused in *Sphaerodactylus*); frontal broad with flat dorsal surface (narrow and convex in *Sphaerodactylus*); quadrate more or less straight with a slightly convex conch (curved and extremely convex conch in *Sphaerodactylus*); high number of foramina in the maxillary facial process (fewer foramina in *Sphaerodactylus*); high, discrete splenial (fused to coronoid in *Sphaerodactylus*); stapedial foramen absent (present in *Sphaerodactylus*);dentary ending at the level of the coronoid eminence (extending beyond the coronoid in *Sphaerodactylus*); and

retroarticular process narrow (broad in *Sphaerodactylus*). Morphology of the manus is very similar between the two genera, both *Ebenavia* and *Sphaerodactylus* having the same (plesiomorphic) phalangeal formula (2-3-4-5-3) and similar relative length of toes, from largest to smallest III>IV>II>V>I.

The copal gecko is clearly differentiated from *E. maintimainty*. Head length in the *E. inunguis* group is 9.2–9.5 mm (~9.5 in the copal gecko and between 5.4–5.9 in *E. maintimainty*), dorsal scales are partially keeled in the *E. inunguis* group and the copal gecko (vs. fully keeled in *E. maintimainty*), and the rostral scale is broad in the *E. inunguis* group and the copal gecko (vs. narrow in *E. maintimainty*). Using the key from Hawlitschek et al. (2018), we were able to confirm that ZFMK 94000 has the rostral scale separated from the nostril (Fig. 5), which is a character that defines *Ebenavia boettgeri*. This identification is compatible with the fact that Madagascan copal mines are only found in the distribution range of *E. safari* and *E. boettgeri*.

Even if the gecko in copal is potentially less than several hundred years old, the material provides an historical record of a living species of *Ebenavia* in the northeast of Madagascar based on the known location of copal deposits (Geirnaert, 2002). The North of Madagascar is a critical area for understanding the current distribution of *Ebenavia* in Madagascar, as ancestral area reconstructions may indicate a colonization of northern Madagascar from the Comoros Islands (Hawlitschek et al., 2017).

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REFERENCES

Arnold EN, Azar D, Ineich I, Nel A (2002) The oldest reptile in amber: a 120-million-year-old lizard from Lebanon. Journal of Zoology 258: 7–10

Arnold EN, Poinar G. (2008) A 100 million year old gecko with sophisticated adhesive toe pads, preserved in amber from Myanmar. Zootaxa 1847: 62–68

Bauer AM, Böhme W, Weitschat W (2005) An early Eocene gecko from Baltic amber and its implications for the evolution of gecko adhesion. Journal of Zoology 265: 327–332

Böhme W (1984) Erstfund eines fossilien Kugelfingergeckos (Sauria: Gekkonidae: Sphaerodactylinae) aus Dominikanischem Bernstein (Oligozän von Hispaniola, Antillen). Salamandra 20: 212–220

Böhme W, Weitschat W (1998) Redescription of the Eocene lacertid lizard *Nucras succinea* Boulenger, 1917 from Baltic amber and its allocation to *Succinilacerta* n. gen. Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg 81: 203–222

Borsuk-Białynicka M, Lubka M, Böhme W (1999) A lizard from Baltic amber (Eocene) and the ancestry of the crown group lacertids. Acta Paleontologica Polonica 44: 349–382

Bosselaers J, Dierick M, Cnudde V, Masschaele B, Van Hoorebeke L, Jacobs P (2010) High-resolution X-ray computed tomography of an extant new *Donuea* (Araneae: Liocranidae) species in Madagascan copal. Zootaxa 2427: 25–35

Castañeda MdR, Sherratt E, Losos JB (2014) The Mexican amber anole, *Anolis electrum*, within a phylogenetic context: implications for the origins of Caribbean anoles. Zoological Journal of the Linnean Society 172: 133–144

Černaňský A, Augé ML (2013) New species of the genus *Plesiolacerta* (Squamata: Lacertidae) from the Upper Oligocene (MP28) of Southern Germany and a revision of the type species *Plesiolacerta lydekkeri*. Palaeontologia 56: 79–94

Daza JD, Abdala V, Thomas R, Bauer AM (2008) Skull anatomy of the miniaturized gecko *Sphaerodactylus roosevelti* (Squamata: Gekkota). Journal of Morphology 269: 1340–1364

Daza JD, Bauer AM (2012) A new amber-embedded sphaerodactyl gecko from Hispaniola, with comments on the morphological synapomorphies of the Sphaerodactylidae. Breviora 529: 1–28

Daza JD, Bauer AM, Stanley EL, Bolet A, Dickson B, Losos JB (In press) An enigmatic miniaturized and attenuate whole lizard from the Mid-Cretaceous amber of Myanmar. Breviora

Daza JD, Bauer AM, Wagner P, Böhme W (2013) A reconsideration of *Sphaerodactylus dommeli* Böhme, 1984 (Squamata: Gekkota: Sphaerodactylidae), a Miocene lizard in amber. Journal of Zoological Systematics and Evolutionary Research 51: 55–63

Daza JD, Stanley EL, Wagner P, Bauer AM, Grimaldi DA (2016) Mid-Cretaceous amber fossils illuminate the past diversity of tropical lizards. Science Advances 2: e1501080

de Queiroz K, Chu L-R, Losos JB (1998) A second *Anolis* lizard in Dominican amber and the systematics and ecological morphology of Dominican amber anoles. American Museum Novitates 3249: 1–23

Fontanarrosa G, Daza JD, Abdala V (2018) Cretaceous fossil gecko hand reveals a strikingly modern scansorial morphology: Qualitative and biometric analysis of an amber-preserved lizard hand. Cretaceous Research 84: 120–133

Geirnaert E (2002) L'ambre – miel de fortune et mémoire de vie. Les Editions du Piat, Saint-Julien-du-Pinet

Glaw F, Vences M (2006) Field guide to the amphibians and reptiles of Madagascar. 3rd edition. Vences & Glaw Verlag GbR, Munich

Hawlitschek O, Toussaint EFA, Gehring PS, Ratsoavina FM, Cole N, Crottini A, Nopper J, Lam AW, Vences M, Glaw F (2017) Gecko phylogeography in the Western Indian Ocean region: the oldest clade of *Ebenavia inunguis* lives on the youngest island. Journal of Biogeography 44: 409–420

Hawlitschek O, Scherz MD, Ruthensteiner B, Crottini A, Glaw F. 2018. Computational molecular species delimitation and taxonomic revision of the gecko genus *Ebenavia* Boettger, 1878. The Science of Nature 105: 1–21

Lazell Jr J (1965) An *Anolis* (Sauria, Iguanidae) in amber. Journal of Paleontology 39: 379–382

Lourenço WR (1996) Premier cas connu d'un sub-fossile de scorpion dans le copal de Madagascar. Comptes Rendus de l'Académie des Sciences, Paris Series IIa 323: 889–891

Nussbaum RA, Raxworthy CJ (1998) Revision of the genus *Ebenavia* Boettger (Reptilia: Squamata: Gekkonidae). Herpetologica 54: 18–34

Penney D., Ono H, Selden PA (2005) A new synonymy for the Madagascan copal spider fauna (Araneae, Selenopidae). Journal of Afrotropical Zoology 2: 41–44

Perrichot V, Néraudeau D (2005) Reptile skin remains in the Cretaceous amber of France. Comptes Rendus Palevol 4: 47–51

Poinar GOJ (1999) Cenozoic fauna and flora in amber. Estudios del Museo Ciencias Naturales de Álava 14: 151–154

Polcyn M, Rogers IJ, Kobayashi Y, Jacobs L (2002) Computed tomography of an *Anolis* lizard in Dominican amber: systematic, taphonomic, biogeographic, and evolutionary implications. Palaeontologia Electronica 5: 1–13

Ragazzi, E. Roghi G., Giaretta A., Gianolla P (2003) Classification of amber based on thermal analysis. Thermochimica Acta 404: 43–54

Ramanamanjato J-B, Mcintyre PB, Nussbaum RA (2002) Reptile, amphibian, and lemur diversity of the Malahelo Forest, a biogeographical transition zone in southeastern Madagascar. Biodiversity and Conservation 11: 1791–1807

Rieppel O (1980) Green anole in Dominican amber. Nature 286: 486-487

Schlüter T, Gnielinski Fv (1987) The East African copal. Its geological, stratigraphic, palaeontologic significance and comparison with fossil resins of similar age. National Museum of Tanzania Occasional Paper, Dar es Salaam, Tanzania 8: 1–32

Sherratt E, Castañeda MdR, Garwood RJ, Mahler DL, Sanger TJ, Herrel A, Losos JB (2015) Amber fossils demonstrate deep-time stability of Caribbean lizard communities. Proceedings of the National Academy of Sciences of the United States 112: 9961–9966

Uetz P, Freed P, Database JHTR (2018) The reptile database. Online at http://www.reptile-database.org/ (last access: July 2, 2018)

Winkler W, Kirchner ECh, Asenbaum A, Musso M (2001) A Raman spectroscopic approach to the maturation process of fossil resins. Journal of Raman Spectroscopy 32: 59–63

Xing LD, Caldwell MW, Chen R, Nydam RL, Palci A, Simões TR, McKellar RC, Lee MSY, Liu Y, Shi HL, Wang K, Bai M (2018) A Mid-Cretaceous embryonic-to-neonate snake in amber from myanmar. Science Advances 4: eaat5042

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Freshwater halacarid mites (Acari: Halacaridae) from Madagascar – new records, keys and notes on distribution and biology

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Abstract. Four freshwater halacarid species were previously recorded from Madagascar. They had been extracted from sandy deposits at the banks of streams and creeks. Recently another two species were found, namely *Porohalacarus alpinus* and *Soldanellonyx monardi*. On the basis of individuals of these two species, as well as of additional material of the four formerly recorded species (*Limnohalacarus cultellatus*, *Limnohalacarus novus*, *Lobohalacarus weberi*, and *Ropohalacarus pallidus*), morphological characters are added to previous descriptions and the male of *P. alpinus* is described. A key is given to adults of Madagascar freshwater halacarid genera. Morphological differences between the presently known African freshwater halacarids are outlined. Geographical and biological data of the six species from Madagascar are presented. All genera and most of the species have world-wide distributions.

Key words. Halacaroidea, riverine sediments, taxonomy, biology, geography.

INTRODUCTION

The database 'Freshwater Animal Diversity Assessment' (FADA) presents a list of 67 freshwater halacarid species and subspecies in 17 genera (Bartsch 2013d). Some of the species are related to marine genera but the majority belong to genera which are restricted to fresh or slightly saline brackish water. Eight truly freshwater halacarid species are recorded from continental Africa, i.e., *Limnohalacarus africanus* Walter, 1935; *L. fontinalis* Walter & Bader, 1952; *L. major* Bader, 1968; *L. marlieri* (Bader, 1968); *L. portmanni* Bader, 1967; *Lobohalacarus weberi* (Romijn & Viets, 1924); *Porohalacarus alpinus* (Thor, 1910); *Ropohalacarus uniscutatus* (Bartsch, 1982); and *Soldanellonyx monardi* Walter, 1919 (Walter 1935; Walter & Bader 1952; Bader 1967, 1968; Green 1984; Green et al. 1974; Bartsch 2008a, 2013a, b).

Collections of the freshwater mite fauna in sandy deposits at the banks of Madagascar streams and creeks, carried out by R. Gerecke and T. Goldschmidt, also included halacarid mites. Recently, records of four species were published (Bartsch 2013b). Sorting of additional samples brought to light another two species, namely *Porohalacarus alpinus* and *Soldanellonyx monardi*, and also several more individuals of the formerly mentioned *Limnohalacarus cultellatus* Viets, 1940; *Limnohalacarus novus* Bartsch, 2013; *Lobohalacarus weberi*; and *Ropohalacarus pallidus* Bartsch, 2013. Morphological characters of the six species from Madagascar are outlined, the male of *Porohalacarus alpinus* is described, biological details are added and discussed. The geographical distribution of the species is summarized in maps.

MATERIAL AND METHODS

The halacarid mites were extracted from banks of streams and creeks by digging pits into the sandy deposits and filtering the seeped water (Karaman-Chappuis Method). Collectors are Drs R. Gerecke and T. Goldschmidt. The MD numbers refer to those in the collectors' collection diary (unpublished). The halacarid mites were partly studied in a drop of glycerine, partly cleared in lactic acid, rinsed in glycerine and mounted in glycerine jelly. Voucher specimens are deposited in the Zoological Museum Hamburg (ZMH), Centrum für Naturkunde (CENAK), University of Hamburg; additional material in the author's collection.

The presentation of the species found on Madagascar starts with a bibliographical list which includes the first description of the species, papers which added morphological details, recent records or keys covering large-scale geographical areas (British Islands, Central Europe, North America) and synonyms. The geographical regions correspond to those outlined in Balian et al. (2008) and Bartsch (2009). These are the Afrotropical, Palaearctic,

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Oriental, Nearctic, Neotropical, and Australian Regions, the Pacific Islands and Antarctica. The latter region includes islands of the southern Atlantic (South Georgia) and southern Indian Ocean (Prince Edward Islands, Crozet Island, St Paul, and Kerguelen).

The illustrations and morphological and biological data are of individuals from Madagascar. Rarely occurring numbers of setae are in parentheses. A figure in square brackets indicates the number of cases involved. Decimal indices are added to notify the position of a structure with reference to anterior – posterior end of the idiosoma.

Abbreviations used in the descriptions, keys, and discussion: AD, anterior dorsal plate; AE, anterior epimeral plate; AP, anal plate; ds-1 to ds-6, first to sixth pair of dorsal idiosomatic setae, numbered from anterior to posterior; GA, genitoanal plate; gac, genital acetabula; glp, gland pore(s), numbered glp-1 to glp-5 from anterior to posterior; GO, genital opening; GP, genital plate; L:H, ratio length to height; LxW, data of length and width; L:W, ratio length to width; mxs, maxillary setae, mxs-1, mxs-2, basal and apical pair of maxillary setae, respectively; OC, ocular plate(s); P-1 to P-4, first to fourth palpal segment; pas, parambulacral seta(e); PD, posterior dorsal plate; PE, posterior epimeral plate(s); pgs, perigenital setae; sgs, subgenital setae. The legs, their segments and claws are numbered from I to IV from anterior to posterior. The leg segments are trochanter, basifemur, telofemur, genu, tibia, and tarsus. The number of setae on the tarsi includes the solenidion but excludes the parambulacral setae. In the illustrations, marginal setae are shown either in dorsal or in ventral aspect but not in both. Unless indicated otherwise, the given length of a segment is that along its dorsal margin.

SYSTEMATICS

Annotated key to adult Afrotropical freshwater halacarid genera and Madagascar species

1a. Genu and telofemur of leg I almost equal in length. Tarsus I with ventromedial spur and pair of short ventral setae. ..... ***Lobohalacarus***
Remarks. In the Afrotropical region, the genus *Lobohalacarus* is represented by a single species, *L. weberi*. The majority of the individuals have a frontal spine whereas the anterior margin of the other freshwater species is arched or truncate.

1b. Genu of leg I shorter than telofemur I. Tarsus I with 0–1 ventral setae..... 2

2a. Gland pores inconspicuous or absent. 3

2b. Dorsum with four to five pairs of distinct gland pores (glp), pair of glp-1 on AD, glp-2 marginally in striated integument, glp-4 and glp-5 in striated integument lateral to PD. 4

3a. With four dorsal plates (AD, pair of OC and PD) and four ventral plates (AE, pair of PE and GP). OC with cornea and large spot of black eye pigment (> 10 µm in diameter). ..... ***Porohalacrus***
Remarks. The only *Porohalacarus* species known from Madagascar and Africa, *P. alpinus*, is characterized by its spots of dark eye pigment, a small one on the AD and a larger one on each OC. The other Madagascan freshwater halacarids have either faintly brown or no eye pigment.

3b. With dorsal shield (AD and PD fused, OC reduced or fused with PE) and ventral shield (AE, PE and GP fused). Neither cornea nor eye pigment present. ..... ***Ropohalacarus***
Remarks. A single species is known from Madagascar, namely *Ropohalacarus pallidus*. A record of another species, *R. uniscutatus*, is from northern Africa (Bartsch 2013). Distinguishing characters are outlined below.

4a. Genital acetabula in posterior part of GP, none situated anterior to the level of GO. Length of anal sclerites about half that of female genital sclerites. ..... ***Soldanellonyx***
Remarks. At present, *Soldanellonyx monardi* is the only *Soldanellonyx* species with records from the Afrotropical region. Worldwide nine species have been described.

4b. Genital acetabula arranged in line along lateral margin of GP (or area representing this plate), most anterior acetabula situated well anterior to GO. Anal sclerites less than 1/3 of the size of genital sclerites. 5

5a. OC not including platelet with gland pore. Ventral plates AE, PE and GA separated by striated integument. Claws I apically with few, delicate tines, basally with lamellar process with about four tines. ..... ***Limnohalacarus cultellatus***

5b. OC including platelet with gland pore. All ventral plates fused. Claws I with J-shaped arranged pectines bearing at least 15 long tines. ..... ***Limnohalacarus novus***
Remarks. These two *Limnohalacarus* species are recorded from Madagascar but further species are mentioned from Africa. All African species are outlined below, after the presentation of *L. novus*.

Madagascan and related halacarid species, notes on morphology, taxonomy, biology, and distribution

Limnohalacarus cultellatus Viets, 1940

L. cultellatus Viets, 1940: 194–200, figs 5–12.
L. cultellatus, Bartsch 2011: 491–493, fig. 2A–C, 2013a: 204–206, figs 1b–h, 2a–h; Pepato & Dos Santos Costa 2015: 5–7, fig. 4A–I.

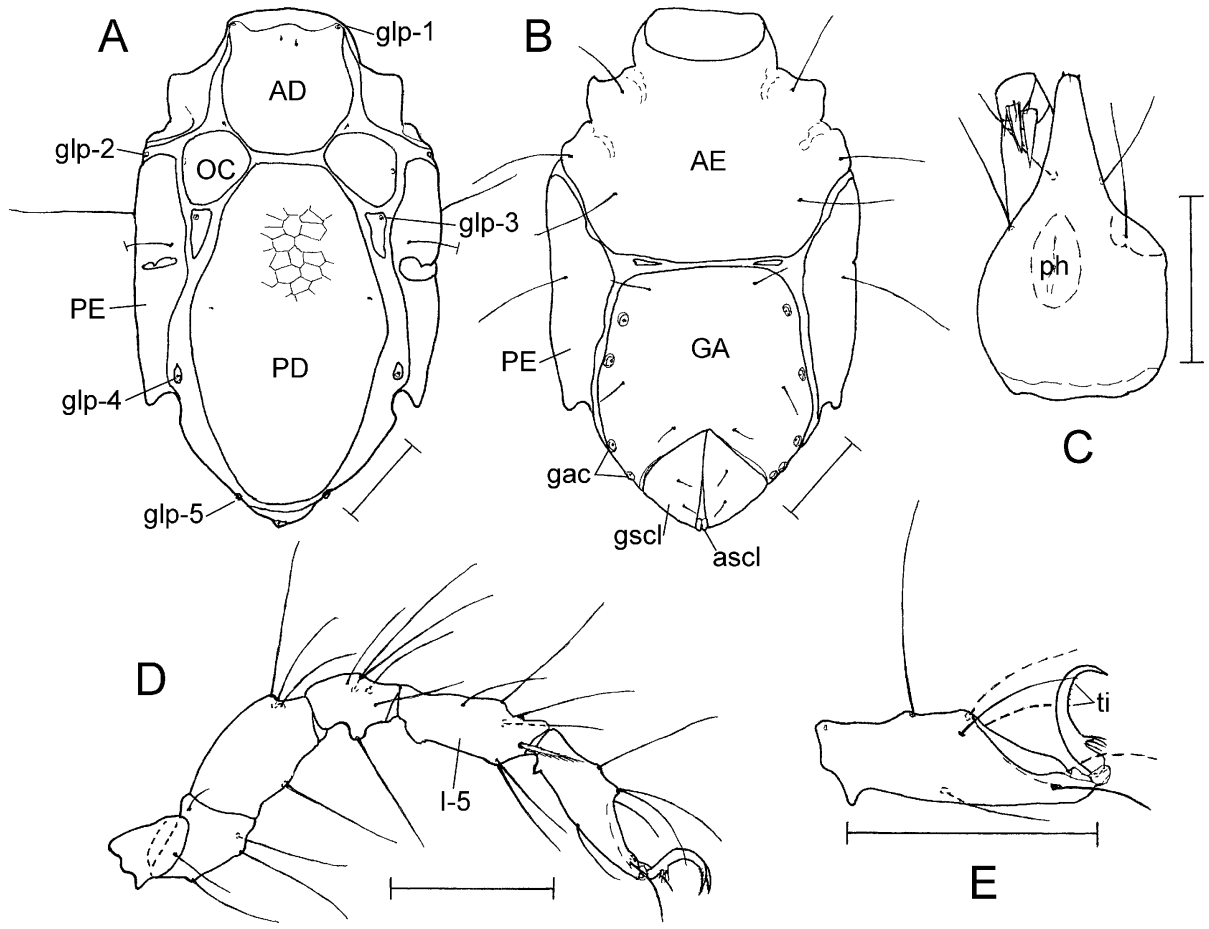

Fig. 1A–E. *Limnohalacarus cultellatus* Viets, 1940, female. **A.** idiosoma, dorsal; **B.** idiosoma, ventral; **C.** gnathosoma, ventral; **D.** leg I, medial; **E.** tarsus I, medial (lateral setae in broken line, lateral claw omitted). (Scale = 50 µm) (AD, anterior dorsal plate; AE, anterior epimeral plate; ascl, anal sclerite; GA, genitoanal plate; gac, genital acetabula; glp-1 to glp-5, first to fifth gland pore; gscl, genital sclerite; OC, ocular plate; PD, posterior dorsal plate; PE, posterior epimeral plate; ph, pharyngeal plate; ti, tines; I-5, tibia of leg I).

L. kakinadus Chatterjee & Chang, 2005: 23–27, figs 1A–H, 2A–D.

Collecting data. South-eastern Madagascar, Fianarantsoa, Ionilahy, stream draining area Marosaro (S from River Ionilahy), 220 m, 21°C, 0.072 mS/cm, 12 Aug. 2001, interstitial (MD 023). – South-eastern Madagascar, Fianarantsoa, Ionilahy, River Ionilahy, 200 m, 23°C, 0.059(11. Aug.)–0.088(13. Aug.) mS/cm, 11/13 Aug. 2001, interstitial (MD 026). – Northern Madagascar, Antsiranana, Antalaha, Marofinaritra, River Andranomenaheli, upstream confluence with River Ankavia (right affluent below MD 135), 70 m, 22.3°C, 0.009 mS/cm, riffle, 04 Nov. 2001 (MD136a).

Short description (Fig. 1A–E). *Female*: Length of idiosoma 255–290 µm [3]. OC and platelet with gland pore separated by striated integument (Fig. 1A), OC about 1.1 times longer than wide. Corneae and spots with eye pigment lacking. AE, PE and GA separated by striated integument (Fig. 1B). Pair of ds-6 present on anal cone (obscured by genital sclerites). GP with four to five pairs of gac, three to four pairs of pgs, genital sclerites with two pairs of sgs. Gnathosoma 1.5–1.7 times longer than wide; pharyngeal plate distinctly removed from basal margin of gnathosoma. Both pairs of maxillary setae slender (Fig. 1C). Legs shorter than idiosoma, length ratio leg I:idiosoma 0.7:1. Length of telofemur I 1.8 times the height (Fig. 1D). Basifemora I to IV with 4, 3, 2, 1 setae, tibiae I to IV with 7, 6, 7, 6 setae. Tibiae I and II each with one bipectinate seta, tibiae III with two bipectinate ventromedial setae, tibia IV with slender, smooth ventral setae. Claws on leg I slender, apically with few

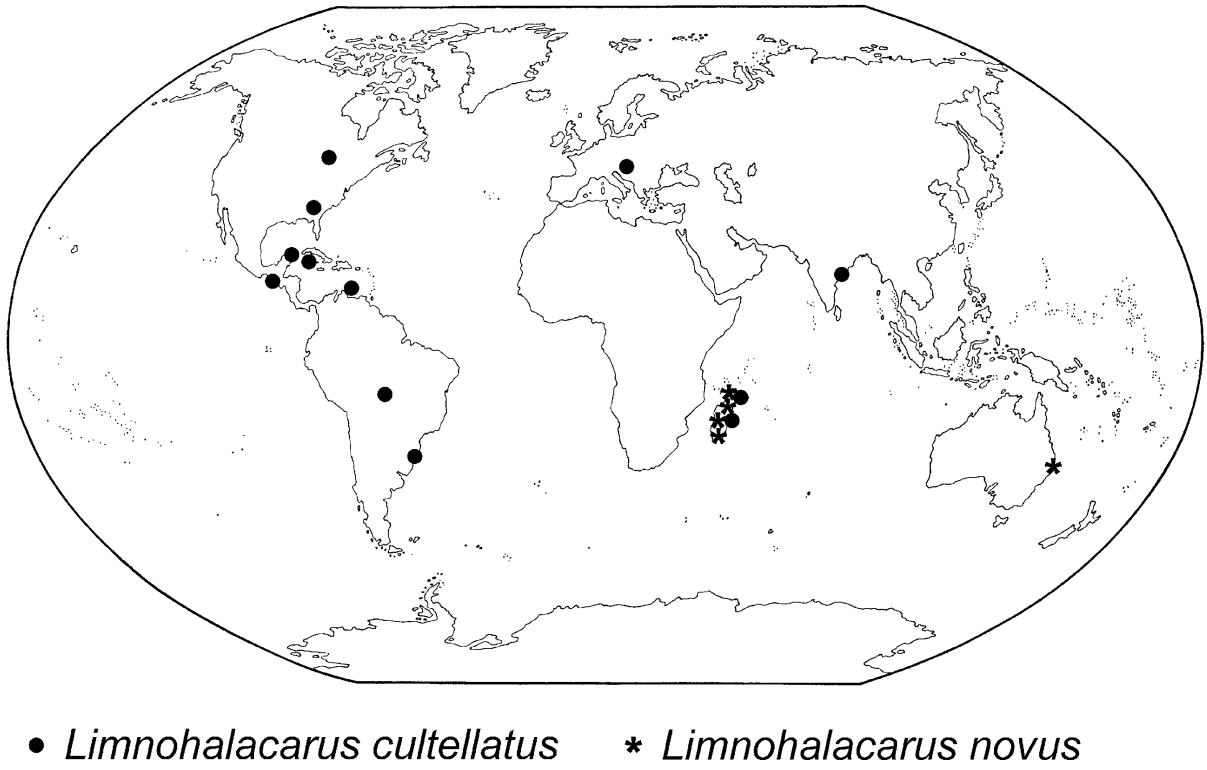

Fig. 2. Records of *Limnohalacarus cultellatus* Viets, 1940 (black spot) and *Limnohalacarus novus* Bartsch, 2013 (asterisk).

(8–10) minute tines (Fig. 1E), basal lamellar process with four tines.

Male: Not present.

Juveniles: Length of deutonymph, protonymph and larva 240 µm [1], 200 µm [1] and 155 µm [1), respectively. Dorsal aspect similar to that of females. AE of larva with pair of epimeral pores. In nymphs GP and anal plate separated by striated integument, in larvae GP lacking.

Remarks. *Limnohalacarus cultellatus* can be distinguished from the other African *Limnohalacarus* species by combination of: dorsal and ventral plates separated and pectines on claws I much more delicate than on claws II to IV. Notes on African *Limnohalacarus* species are given below.

Biology. At present there is no record of a male, neither from Africa nor from other parts of the world.

One of the females included an ovoid excretory body, 125 µm long, 60 µm wide, the centre (10 µm in diameter) is dark, the margin hyaline and delicately stratified. One of the females held an egg, 50 µm long, 55 µm wide.

Geographical distribution (Fig. 2) (cf. Bartsch 2011, 2013a; Pepato & Dos Santos Costa 2015; Ojeda et al. 2016):

Afrotropical Region. – Madagascar;
Palaearctic Region. Europe: – Hungary;
Oriental Region. – India (Andhra Pradesh);
Nearctic Region. – United States (Georgia, Wisconsin ?);
Neotropical Region. – Brazil (Mato Grosso, Rio Grande do Sul) – Cayman Islands (Grand Cayman) – El Salvador – Mexico (Quintana Roo) – The Netherlands Antilles (Bonaire, Curaçao) – Venezuela (Margarita Island).

Limnohalacarus novus Bartsch, 2013

L. novus Bartsch, 2013a: 206–210, figs 3a–h, 4a–g.
L. billabongis, Bartsch 2008b: 127, 128.

Collecting data. Central Madagascar, Antananarivo, Anjazorobe, River Ranonisoanavola (larger stream E from main mountain chain), 1200 m asl, 13.2°C, 0.058 mS/cm, interstitial, 23 Jul. 2001 (MD 012). – South-eastern Madagascar, Fianarantsoa, Ionilahy, stream draining area Marosaro (S from River Ionilahy), 220 m, 21°C, 0.072 mS/cm, interstitial, 12 Aug. 2001 (MD 023). – South-eastern Madagascar, Fianarantsoa, Ionilahy, River Ionilahy,

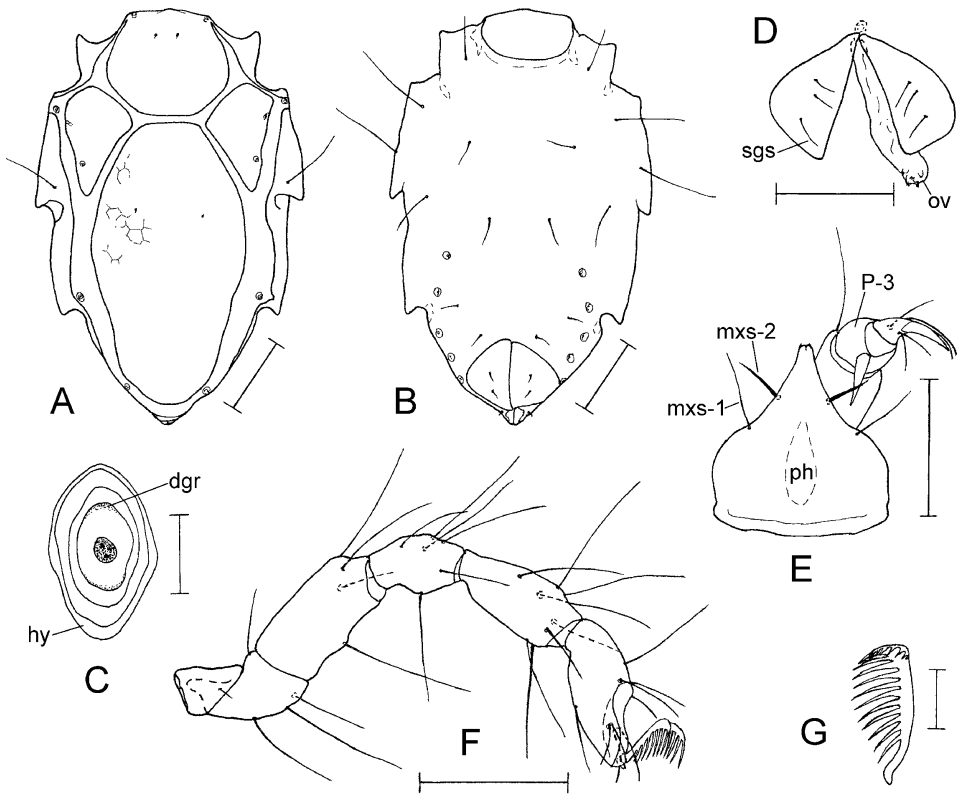

Fig. 3A–G. *Limnohalacarus novus* Bartsch, 2013, female. **A.** idiosoma, dorsal; **B.** idiosoma, ventral; **C.** excretory body, ventral; **D.** genital area with ovipositor; **E.** gnathosoma, ventral; **F.** leg I, medial; **G.** claw I, ventral. (A–F, scale = 50 µm; G, scale = 10 µm) (dgr, dark granules; hy, hyaline part; mxs-1 and mxs-2, basal and apical maxillary seta, respectively; ov, ovipositor; ph, pharyngeal plate; P-3, third palpal segment; sgs, subgenital seta).

200 m, 23°C, 0.059(11. Aug.)–0.088(13. Aug.) mS/cm, interstitial, 11/13 Aug. 2001 (MD 026). – South-eastern Madagascar, Fianarantsoa, Ionilahy, small stream crossing the railroad east from village, 200 m, 19.9°C, 0.083 mS/cm, 15 Aug. 2001 (MD027). – Southern Madagascar, Tulear, Tsimelahy, River Antarantsa, ca 1 km upstream from village, 300 m, 20.4°C, 0.171 mS/cm, interstitial, 04 Sep. 2001 (MD 058). – Central Madagascar, Antanarivo, Ankaratra, Reserve Manjakatompo, left affluent of River Mahiavona, EM Mantsina, 1750 m, 14.1°C, 0.003 mS/cm, interstitial, 08 Oct. 2001 (MD107). – North-western Madagascar, Majunga, Adjamangirana, stream in dry forest, upstream, rice field area (road to the village of Tsaratanana), 220 m, 30.8°C, 0.008 mS/cm, interstitial, 19 Oct. 2001 (MD115). – Northern Madagascar, Antsiranana, Antalaha, Marofinaritra, River Antsohibe, upstream confluence with River Ankavia (5 km NE Amparihimena), 70 m, 25.2°C, 0.008 mS/cm, riffle, 03 Nov. 2001 (MD135). – Northern Madagascar, Antsiranana, Antalaha, Marofinaritra, River Andranomenaheli, upstream confluence with River Ankavia (right affluent below MD 135), 70 m, 22.3°C, 0.009 mS/cm, riffle, 04 Nov. 2001 (MD136a). – Northern Madagascar, Antsiranana, Maroambihy (Sambava), left affluent of River Lokoho upstream from the village, 90 m, 26.0°C, 0.010 mS/cm, interstitial, 12 Nov. 2001 (MD149). – Northern Madagascar, Antsiranana, Joffreville (M. d'Ambre), River Antomboka, downstream large cascade, 850 m, 20 Nov. 2001 (MD163). – Northern Madagascar, Antsiranana, Joffreville (Montagne d'Ambre), River Manques in Reserve Fontenay, 580 m, interstitial, 21 Nov. 2001 (MD 165).

Short description (Fig. 3A–G). *Female*: Length 206–289 µm [20]. OC including platelet with glp-3 (Fig. 3A), L:W of OC 1.4–1.6:1. Length ratio of PD:AD 2.6–2.7:1. Pair of ds-2 absent. Ventral plates AE, PE and GP fused (Fig. 3B). Area corresponding to GP with three pairs of pgs, five to six pairs of gac and on each genital sclerite two (three) sgs. Ovipositor short and narrow (LxW 74 x 10 µm), very faintly sclerotized, genital spines very delicate and short, 2 µm in length, and arising from minute papillae (Fig. 3D). Anal slit less than 10 µm long and guarded by pair of short anal sclerites. Gnathosoma about 1.1 times longer than wide. Pair of mxs-2 shorter but wider than mxs-1 (Fig. 3E). Legs shorter than idiosoma,

length ratio leg I:idiosoma 0.7:1. Length of telofemur I 2.1–2.3 times the height (Fig. 3F). Tibiae I to IV with 8, 7, 7, 6 setae [14]. Ventromedial seta on tibia II and both ventromedial setae of tibia III bipectinate; setae on legs I and IV smooth. Claws I to IV with J-shaped arranged pectines (Fig. 3G), extending from apical lateral flank and along medial flank to basis of claw. On claws II to IV basal tines partly fused to a lamellar process.

Male: Not present.

Juveniles: Length of deuto-, protonymphs and larvae 231–275 µm [13], 180–226 µm [7] and 142–170 [5] µm, respectively. In contrast to adults, OC and posterior gland-bearing platelet separated by transverse striae. Ventral plates AE, PE and GP of nymphs separated from each other by striated integument, in larvae GP absent and AE with pair of epimeral pores.

Biology. Eleven of 15 females studied held an egg. The length x width of the eggs ranged from 35 x 35 to 100 x 50 µm. The eggs are not deposited in the substratum but attached to tibiae IV. One-third of the females had a single cocoon fixed with a slender stem, the latter 2–3 µm wide. The length of the cocoons was about 103–113 µm, the diameter 60–64 µm. Each one enclosed a single embryo.

Limnohalacarus species have the excretory material accumulated within an ovoid, compressed body (cf. Walter 1914; Petrova 1966; Ramazotti & Nocentini 1960; Pepato & Dos Santos 2015). In the material studied, 11 (73 %) of 15 females, 9 (22%) of 27 deutonymphs and one (22%) of six protonymphs held such a body, but none of four larvae. The body was dorsal to the gut, in some individuals it had a dark centre, surrounded by concentrically arranged more or less transparent layers (Fig. 3C). In one female the excretory body was almost uniformly dark, in another one hyaline, the body recognizable mainly because refraction of light. In one female (length 255 µm) this body was 108 µm long, 71 µm wide and 41 µm thick, the general size range in length was 95–158 µm, in width 50–92 µm. The length of the excretory body equalled 0.4–0.5 times the length of the female idiosoma. In deutonymphs the stratified body was 60–85 µm long, 45–95 wide, in a protonymph 50 µm long, 36 µm wide, i.e., a length of 0.3–0.4 and 0.2 of that of the nymphal idiosoma, respectively. Such a body was present/absent independent of the age of the instar, e.g. it was absent both in assumedly recently hatched females and in ovigerous ones and also in those carrying a cocoon (or their remnants) fixed to the tibiae.

Remarks. Adults of *Limnohalacarus cultellatus* and *L. novus*, the two species known from Madagascar, can easily be separated by (1) the shape of the ocular plates, namely OC hardly longer than wide (L:W 1.1:1) and not including the platelet with a gland pore versus OC 1.3 times longer than wide and including the platelet with gland pore, (2) the ventral plates, separated versus fused to a shield, (3) the length of the gnathosoma, at least 1.5 times longer than wide versus 1.1 times or less, and (4) the claws on tarsus I, with few delicate versus numerous long tines. Juveniles of both species have the ventral plates and the OC and gland-pore bearing platelet separated but can be distinguished by the shapes of gnathosoma and claw I.

Compared with African species, *L. novus* turns out to be most similar to *L. portmanni*. Both are of about the same size, their length 206–289 and 217–289 µm, respectively, but the PD of *L. novus* is not as slender as in *L. portmanni* and the length ratio PD:AD is 2.6–2.7:1 in *L. novus* but 3.1–3.3:1 in *L. portmanni* (Bartsch 2013a).

Geographical distribution (Fig. 2) (cf. Bartsch 2013a):

Afrotropical Region. – Madagascar;

Australian Region. – Australia (Queensland – Moreton Bay, North Stradbroke Island, not Moreton Island).

Limnohalacarus species from the Afrotropical Region

The *Limnohalacarus* species recorded from the Afrotropical region are: *L. africanus*, *L. cultellatus*, *L. fontinalis*, *L. major*, *L. marlieri*, *L. novus*, and *L. portmanni*. Relying on often vague descriptions, the most specific morphological characters of the six African species are:

Limnohalacarus africanus. Characters (according to Walter 1935, Green 1984 and Bartsch 2013a): Length 330 µm, OC and gland pore-bearing sclerite separated, ventral plates separated, GA of female with 8–9 (up to 12 according to Green 1984) pairs of gac and three pairs of pgs, its genital sclerites with two pairs of sgs; L:W of female gnathosoma 1.6:1 (Walter 1935: p. 74), but distinctly less in the deutonymph (Walter 1935: fig. 4), none of setae on tibiae I bipectinate, pectines on claws I J-shaped and bearing numerous long tines. Distribution: Burkina Faso (Upper Volta) (well at Banfora) (Walter 1935), West Cameroon (Debundska Lake) (Green et al. 1974), South Sudan (Lake No) (Green 1984).

Limnohalacarus fontinalis. Characters (according to Walter & Bader 1952 and Bartsch 2013a): Length 310–370 µm, gland pore included in elongate OC; ventral plates fused, L:W of gnathosoma 1.1:1; tibiae I to IV with 8, 7, 7, 6 setae, respectively, claws I with numerous long tines. Distribution: Kenya (Mombasa, from well with slightly saline water) (Walter & Bader 1952), South Sudan (Lake No) (Green 1984).

Limnohalacarus major. Characters (according to Bader 1968): Length 465 µm, distinctly larger than the other species (their length 224–370 µm), gland pore included in elongate OC; ventral plates fused, gnathosoma slender, its L:W 1.6:1. Distribution: DR Congo (Zaire) (Lake Tanganyika) (Bader 1968).

Limnohalacarus marlieri. Characters (according to Bader 1968 and André & N'Dri 2012): Length of female 305 µm, of male 350 µm. OC elongate, 1.4 times longer than wide. Length ratio PD:AD 3.4:1. Ventral plates fused. Female with eight pairs of gac posterior and posterolateral to GO. Number of gac along margins of area representing GA not known. Gnathosoma short, L:W 1.1–1.2:1. *Limnohalacarus marlieri* is very similar to both *L. fontinalis* and *L. portmanni*, it is classified as a junior synonym and omitted in the following key. Distribution: DR Congo (Zaire) (Lake Tanganyika) (Bader 1968).

Limnohalacarus portmanni. Characters (according to Bader 1967 and Bartsch 2013a): Length of females 224–250 µm, of males 217–289 µm, gland pore included in elongate OC; length ratio PD:AD 3.1–3.3:1; ventral plates fused, L:W of gnathosoma 1.2:1. Female with up to seven pairs of gac and three pairs of pgs, each genital sclerite with (two to) four sgs. All claws with J-shaped arranged pectines. Distribution: DR Congo (Zaire) (Lake Tanganyika, from shallow water sediment) (Bader 1968).

Characters of *Limnohalacarus cultullatus* and *L. novus* are outlined above.

Key to adult Afrotropical *Limnohalacarus* species

1a. All ventral plates separated. 2
1b. All ventral plates fused to a single shield. 3
2a. Claws on tarsus I with numerous distinct tines. ..... ***africanus***
2b. Claws I apically and in middle with a few delicate tines, basally with narrow lamella bearing tines. ..... ***cultellatus***
3a. Length of idiosoma exceeding 450 µm. L:W of gnathosoma 1.6:1. ..... ***major***
3b. Length of idiosoma between 200–400 µm. L:W of gnathosoma 1.1–1.2:1. 4
4a. Length of idiosoma about 300–400 µm. ... ***fontinalis***
4b. Length of idiosoma between 200 and almost 300 µm. 5
5a. L:W of PD 2.1:1. Length ratio of PD:AD 3.1–3.3:1. ..... ***portmanni***
5b. L:W of PD 1.9:1. Length ratio of PD:AD 2.6–2.7:1. ..... ***novus***

***Lobohalacarus weberi* (Romijn & Viets, 1924)**

Walterella weberi Romijn & Viets, 1924: 217–220, figs 3–6.
Lobohalacarus weberi, Schwoerbel 1955: 147, fig. 1; Green and MacQuitty 1987: 162, fig. 68A–D; Bartsch 2006: 128–130, fig. 5-8a–f, 2007: 74–80, fig. 2, 2011: 493–494, fig. 3A–C.
Walterella weberi quadripora Walter, 1947: 236–237, fig. 35.
Lobohalacarus weberi quadriporus, Viets 1959: pl. 4, fig. 42, pl. 5, fig. 47.
Lobohalacarus weberi gotoensis Imamura, 1970: 455–457, figs 1 and 2.
Lobohalacarus weberi tristanensis Bartsch, 1995: 171–175, figs 1–13.

Species with vague descriptions but expected to belong to *L. weberi*:
Halacarus processifer Walter, 1919a: 21–23, fig. 1–3 (only protonymph known);
Lobohalacarus hummelincki Viets, 1940: 191–194, fig, 1,2I and II, 3III and IV, 4;
Lobohalacarus bucharensis Jankovskaja, 1967: 109–114, fig. 1(1–7), 2(1–7), 3(1–6) (only deuto- and protonymph known);
Lobohalacarus bunurong Harvey, 1988: 363–365, figs 1–6.

Collecting data. Central Madagascar, Antananarivo, Anjazorobe, River Ranonisoanavola (larger stream E from main mountain chain), 1200 m asl, 13.2°C, 0.058 mS/cm, interstitial, 23 Jul. 2001 (MD 012). – South-eastern Madagascar, Fianarantsoa, Ionilahy, stream draining area Marosaro (S from River Ionilahy), 220 m, 21°C, 0.072 mS/cm, interstitial, 12 Aug. 2001 (MD 023). – South-eastern Madagascar, Fianarantsoa, Ionilahy, small stream crossing the railroad east of village, 200 m, 15 Aug. 2001 (MD027). – South-eastern Madagascar, Fianarantsoa, Andrambovato, stream 3 km E from the village, upstream from the cascade, 900 m, 20 Aug. 2001 (MD 038). – Southern Madagascar, Tulear, Tsimelahy, River Antarantsa, ca 1 km upstream from village, 300 m, 20.4°C, 0.171 mS/cm, interstitial, 04 Sep. 2001 (MD 058). – Central Madagascar, Antanarivo, Ankaratra, Reserve Manjakatompo, left affluent of River Mahiavona, EM Mantsina, 1750 m, 14.1°C, 0.003 ms/cm, interstitial, 08 Oct. 2001 (MD107). – Northern Madagascar, Antsiranana, Andapa, right affluent of River Ambendrana downstream, large cascade, 600 m, 11 Nov. 2001 (MD147).

Short description (Fig. 4A–E). *Female*: Length (with frontal spine included) 249–304 [25] µm, 228–273 (if frontal spine excluded). All Madagascar specimens with frontal spine, spine generally slender (Fig. 4C) and about 21–31 µm long, one female with 19 µm-long spine. Dorsal plates uniformly foveate, foveae 3 µm wide. AD and anterodorsal part of AE fused (Fig. 4A). Opposing edges of AD and PD truncate. OC oblong, without cornea or eye pigment. Dorsal setae minute, seven pairs present, most posterior pair on PD. Ventral plates AE, PE and GA fused to a shield (Fig. 4B). A pair of epimeral pores about levelling with aperture of legs II. GO extending anteriad to the level of apertures of legs IV. Area corresponding to PE with one rather short dorsal and two long ventral

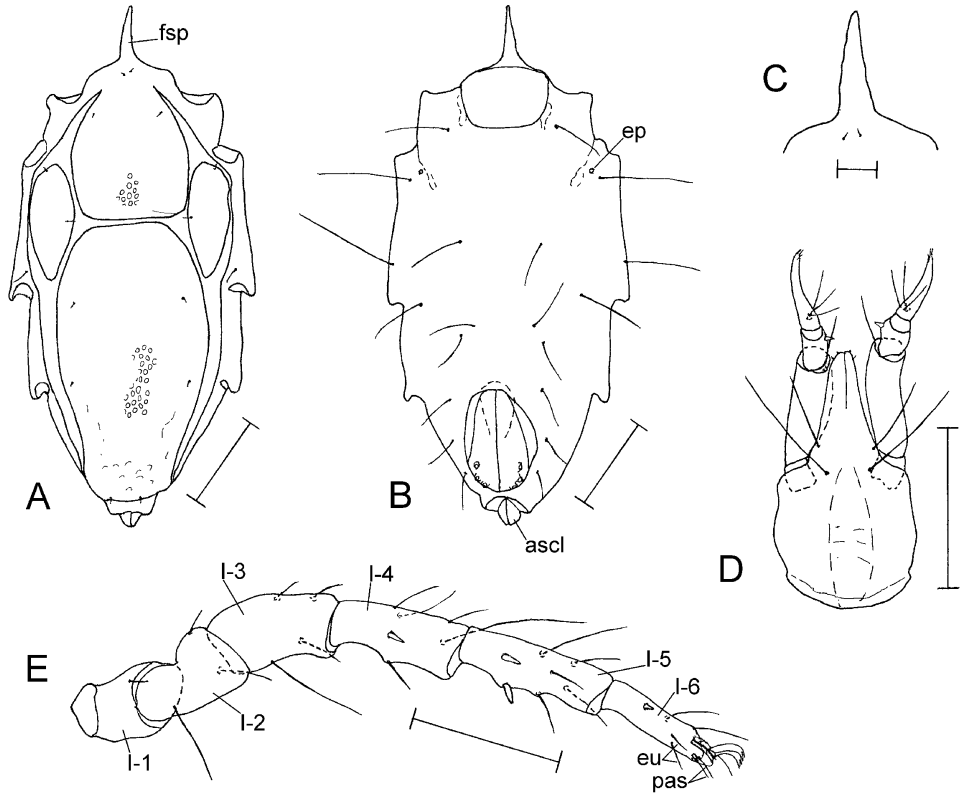

Fig. 4A–E. *Lobohalacarus weberi* (Romijn and Viets, 1924), female. **A.** idiosoma, dorsal; **B.** idiosoma, ventral; **C.** frontal spine; **D.** gnathosoma, ventral; **E.** leg I, medial. (A, B, D, E, scale = 50 µm; C, scale = 10 µm) (ascl, anal sclerite; ep, epimeral pore; eu, eupathid setae; fsp, frontal spine; pas, parambulacral setae; I-1 to I-6, trochanter, basifemur, telofemur, genu, tibia, and tarsus of leg I).

setae, genital area with four to five pairs of setae. Each genital sclerite with two to three gac. Gnathosoma slender, 1.8 times longer than wide. Rostrum almost extending to end of P-2 (Fig. 4D). P-2 with single dorsal seta, P-3 with medial spur. Length ratio leg I:idiosoma 0.8:1, following legs somewhat shorter. Telofemur and genu I equal in length (Fig. 4E). Telofemora III and IV with 2/0 dorsal/ventral setae. Genu I with two ventral setae, generally one seta spur-, the other seta-like, rarely both setae spur-like. Tibia I ventrally with two pairs of setae, one pair spiniform, one bristle-like; ventral flank of tibiae II to IV with (zero to) one smooth and (one to) two pectinate setae. Tarsus I with ventromedial spur, apically with pair of eupathidia (short sensory setae) and pair of doubled pas (Fig. 4E); tarsus III with 4/1 dorsal/ventral setae, and tarsus IV with 3/1 setae. Lateral fossa membrane of tarsus I enlarged, its length 7 µm, height 6 µm, on following tarsi lateral and medial fossa membrane small both in length and height. Claws on tarsus I smaller than those of following tarsi.

To get an idea of variants in respect to external characters, as commonly found in *Lobohalacarus weberi* (Bartsch 1995, 2007, 2011), details of 25 uncleared females were examined in a drop of glycerine, but some females were damaged or the characters in question obscured. The character studied were (1) frontal spine: present [25]; (2) number of gac per genital sclerite: 2 [12], 3 [38]; (3) number of pgs in each half of genital plate: 3 [1], 4 [22], 5 [26]; (4) combination of spines (sp) and bristles (br) on genu I: sp/br [49], sp/sp [1]; (5) number of dorsal/ventral setae on telofemur III: 2/0 [47], 2/1 [1]; (6) number of dorsal/ventral setae on telofemur IV: 2/0 [49], 2/1 [0]; (7) number of pectinate (p) + smooth (s) setae on tibia II: 2p+1s [46], 1p+1s [4]; (8) number of pectinate (p) + smooth (s) setae on tibia III: 2p+1s [31], 1p+1s [14]; (9) number of pectinate (p) + smooth (s) setae on tibia IV: 2p+1s [48], 1p+1s [0]; (10) number of dorsal/ventral setae on tarsus III: 4/1 [43], 4/0 [1], 3/0 [0]; (11) number of dorsal/ventral setae on tarsus IV: 4/1 [1], 3/1 [45], 3/0[2].

Male: Not present.

Juveniles: Length (frontal spine excluded) of deutonymphs 230–247 [3] µm, protonymphs 210 [2] µm and larvae 130–162 [4] µm. All instars with slender frontal spine, in one larva that spine very delicate. Ventral plates AE, PE and GA separated. Tarsus I with three dorsal setae, dorsolateral solenidion, enlarged lateral fossa membrane, ventromedial spur, and two ventral eupathidia.

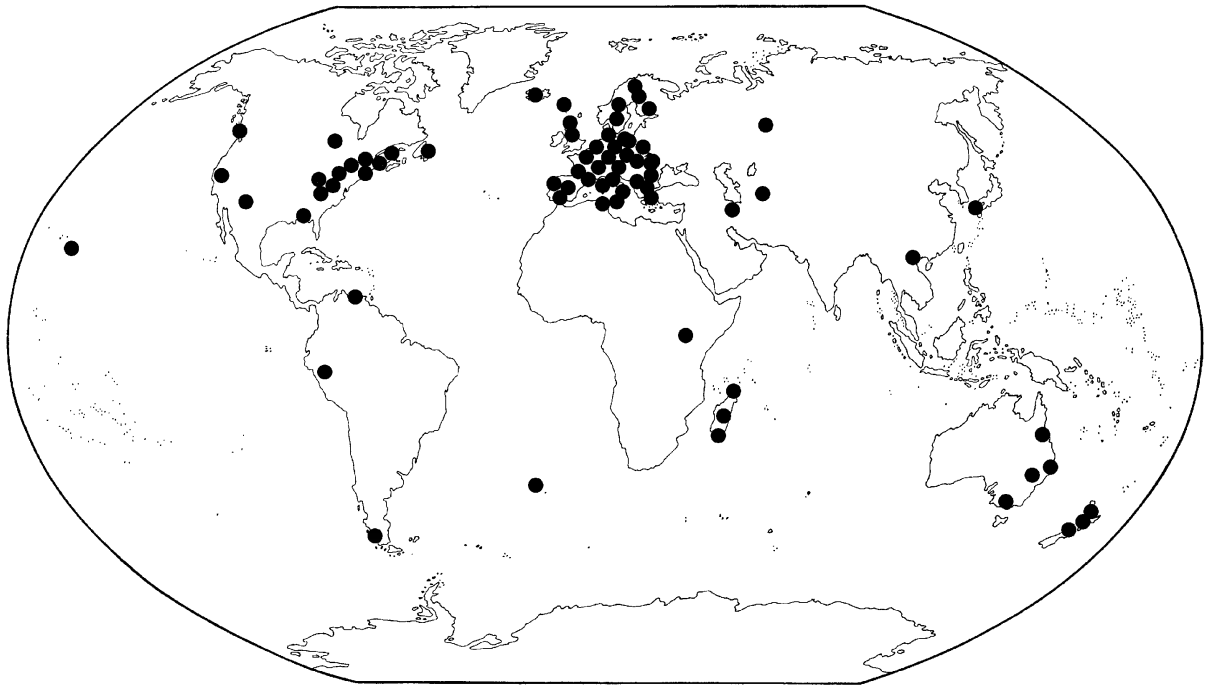

Fig. 5. Records of *Lobohalacarus weberi* (Romijn & Viets, 1924) and species of the *L. weberi* complex.

Biology. Eighteen of 26 females enclosed an egg, one female two eggs. The smallest egg was globular and had a size of 40 x 40 µm, the largest one reached a size of 110 x 56 µm.

No male was found in the material from Madagascar. Though *L. weberi* is one of the very wide-spread and commonly recorded species reliable records of males are lacking.

Remarks. Two easily recognized characters used for identification of *Lobohalacarus weberi* are the frontal spine and the ventral shield. These characters are known to vary, though rarely. In the samples from Madagascar, all individuals have a pointed frontal spine and a ventral shield. In almost all Madagascan specimens the frontal spine is very slender, similar to that illustrated by Schwoerbel (1955: fig. 1(4)). In general, the spine is somewhat shorter but wider (cf. Romijn & Viets 1924: figs 3 and 4; Bartsch 2006: fig. 5–8a and b). Among material from Inaccessible Island, Tristan da Cunha Islands, three out of six females had no frontal spine. In two of these three specimens the anterior margin of the idiosoma was evenly arched, in one the spine was reduced to a hood-like process (Bartsch 1995: figs 12 and 13). Out of 92 individuals from New Zealand, one female had no spine but an evenly rounded anterior margin, 91 females had a frontal spine (Bartsch 2007: fig. 2A–C). In the same material one of the females had no ventral shield, instead AE, PE and GA were separated (Bartsch 2007: fig. 2C). *Lobohalacarus weberi* is expected to be highly variable in its morphology rather than to be represented by several cryptic species. Studies on the influence of habitat parameters on character expression do not exist.

Geographical distribution of *Lobohalacarus weberi* and the *Lobohalacarus weberi* complex (Fig. 5) (cf. Bartsch 2008a, b, 2011, 2014a; Pešić et al. 2010; Fritz & Feminella 2011; Stolbov et al. 2018):

Afrotropical Region. – Kenya – Madagascar – Tristan da Cunha Islands;

Palaearctic Region. Europe: – Austria – Belgium – United Kingdom (England, Northern Ireland, Scotland) – Bulgaria – Denmark – Faeroerne – Finland – France – Germany – Greece – Hungary – Iceland – Italy – Macedonia – Monte Negro – Poland – Portugal – Romania – Switzerland – Spain – Sweden – The Netherlands. Northern Africa: – Tunisia. Asia: – Iran – Japan (*L. weberi gotoensis*—Imamura 1970) – Russia (Tyumen region) – Uzbekistan (*Lobohalacarus bucharensis*—Jankovskaja 1967);

Nearctic Region. – Canada (British Columbia, New Brunswick, Newfoundland, Ontario, Quebec). – United States (Alabama, Arizona, California, Colorado, Georgia, Illinois, New Hampshire, New Mexico, New York, North Carolina, Rhode Island, Tennessee, Virginia);

Neotropical Region. – Chile (Magallanes) – Peru (Lake Levandera, *Lobohalacarus processifer*) – Venezuela (near Higuerote, *Lobohalacarus hummelincki*);

Australian Region. – Australia (New South Wales (*Lobohalacarus* sp.), Queensland, Victoria (*Lobohalacarus bunurong* and *Lobohalacarus* sp.), the author expects these specimens to belong to the *L. weberi* complex). – New Zealand (North and South Island);

Pacific Islands. – Hawaiian Islands.

***Porohalacarus alpinus* (Thor, 1910)**

Halacarus alpinus Thor, 1910. 348–351, figs 1 and 2.

Porohalacarus alpinus, Thor 1922: 110, 111; Bartsch 1973: 117–119, figs 1–21, 2007: 80–82, fig. 3, 2011: 497–498, fig. 6A–D; Green & MacQuitty 1987: 164, fig. 69A–D.

Porohalacarus alpinus alpinus Viets 1927: 465–469, figs 3–8.

Porohalacarus alpinus alpinus, Bartsch 1987: 85, 2006: 130–132, figs 5-9a–f.

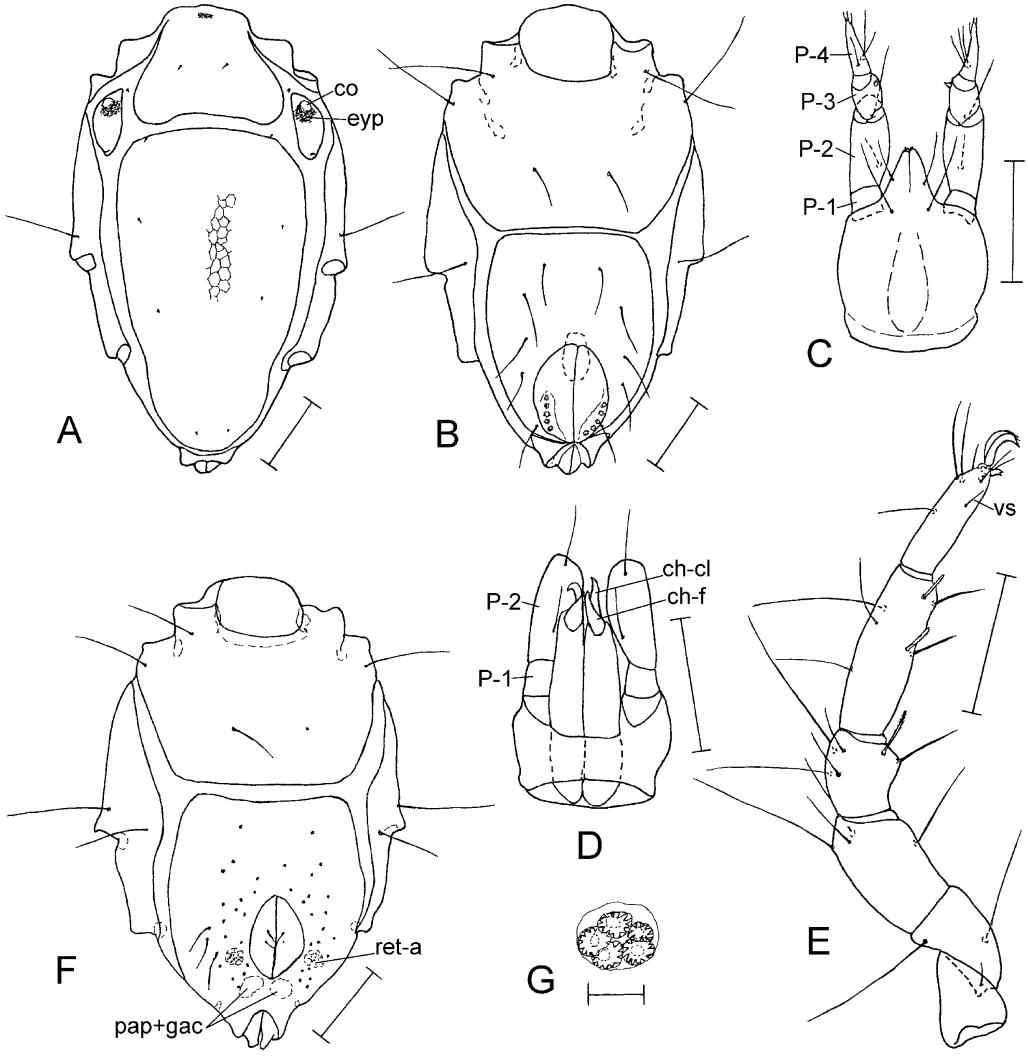

Fig. 6A–G. *Porohalacarus alpinus* (Thor, 1910). **A.** idiosoma, dorsal, female; **B.** idiosoma, ventral, female; **C.** gnathosoma, ventral, female; **D.** gnathosoma, dorsal (P-3 and P-4 omitted), female; **E.** leg I, medial, female; **F.** idiosoma, ventral, male; **G.** papilla with genital acetabula, male. (A–F, scale = 50 µm, G, scale = 10 µm) (ch-cl, cheliceral claw; ch-f, dorsal flap-like process of chelicera; co, cornea; eyp, eye pigment; pap+gac, papilla with genital acetabula; P-1 to P-4, first to fourth palpal segment; ret-a, reticulate area; vs, ventral seta).

Porohalacarus alpinus brachypeltatus Viets, 1927: 469, figs 9, 10.
Porohalacarus alpinus brachypeltatus, Bartsch 1987: 85–86, figs 2 and 3, 2006:132, 5-10a, b.

Collecting data. Southern Madagascar, Tulear, Tsimelahy, River Antarantsa, ca 1 km upstream from village, 300 m, 20.4°C, 0.171 mS/cm, interstitial, 04 Sep. 2001 (MD 058). – Northern Madagascar, Antsiranana, Sambava, Maroambihy, left affluent of River Lokoho upstream from the village, 90 m, 26.0°C, 0.010 mS/cm, interstitial, 12 Nov. 2001 (MD149).

Short description (Fig. 6A–G). *Female*: Length 280–318 µm [10]. Dorsal plates reticulate, in anterior part of PD reticulation honey comb-like, in posterior part presenting a longitudinal pattern. OC with cornea. AD and OC with spots of black eye pigment (Fig. 6A), that on AD narrow, 13 µm wide, spot on OC 15–18 µm in diameter. Dorsal setae very small, their position as illustrated in Fig. 6A, ds-6 on PD removed from posterior margin. Surface of ventral plates finely porose. Genital plate with (four to) five pairs of pgs, each genital sclerite with (four to) five external acetabula. Interval between anterior margin of GP and that of GO somewhat longer than the latter's length (Fig. 6B). Gnathosoma hardly longer than wide (Fig. 6C). Rostrum shorter than gnathosomal base and hardly extending to middle of P-2. Palps four-segmented, lateral to rostrum, i.e., distance between pair of P-1 more than their width. P-2 with two dorsal setae (Fig. 4D), P-3 with medial spur. Chelicera with claw and wide, flap-like dorsal process. Legs slender, shorter than idiosoma, length of legs I and IV 0.7 times that of idiosoma. Genu I much shorter than telofemur I (Fig. 6E). Tibiae I to IV with 4, 3, 2, 2 ventral setae, in addition tibiae III and IV with short, faintly pectinate mid-segmental medial seta. Tarsus I with single slender ventral seta (Fig. 6E), following tarsi without ventral setae. Paired claws with delicate tines.

Male: Length of idiosoma 286 µm, width 185 µm [1]. Dorsal aspect similar to that of females, plates similar in shape, length:width ratio and ornamentation. Length of AD 65 µm, width 93 µm, length of OC 40 µm, width 20 µm, length of PD 188 µm, width 130 µm. GP and AP fused to GA, length of that plate 148 µm, width 121 µm, GA slightly wider than female GP. Length of male GO 50 µm, width 33 µm, distance between GO and anterior margin of GA 58 µm, i.e., 1.1 times longer than GO. GA with 19 pgs on one side, 20 on the other side; one of genital sclerites with one, the other with two sgs. Lateral to posterior part of GO a circular area present, 10–12 µm in diameter, with internal bars forming reticulate ornamentation (Fig. 6F, ret-a). Posterior to GO a pair of dome-like areas, 12–14 µm in diameter, each with five gac (Fig. 6G). Each acetabulum, about 7 µm in diameter, with an inner central papilla, 3 µm in diameter, and surrounded by inward crooked teeth. Length of spermatopositor slightly more than that of GO. Shape of gnathosoma and legs similar to those of females.

Juveniles: With two nymphal and a larval instar. Length of deutonymphs 240–263 µm [6], of protonymphs 186–210 µm [6] and of larvae 140–185 [6] µm. All instars with dark spots of eye pigment.

Biology. Fifteen out of 20 females were ovigerous, the other five held no eggs. The size (length x diameter) of the eggs was between 55 x 63 µm and 88 x 75 µm.

Remarks. The females in the Madagascan material have five (rarely four) external acetabula on each genital sclerite. In populations from other parts of the world the number of acetabula is known to vary between four and nine (Bartsch 2011). In Europe two varieties are known, *P. a. alpinus* and *P. a. brachypeltatus*. Discriminating characters in females are the length of the idiosoma, i.e., 297–371 versus 248–270 µm, and the position of the GO in relation to length of the GP, namely distance from anterior margin of GO to that of GP about the same versus about half the length of GO, respectively (Viets 1927: fig. 6 versus fig 9; Bartsch 2006: fig. 5-9b versus fig. 5-10a). Similar, nymphs of *P. a. alpinus* have, in contrast to *P. a. brachypeltatus*, a larger distance between the area with genital acetabula and the anterior margin of GP. A rather inconspicuous difference is that the PD of *P. a. alpinus* is slightly longer than that of *P. a. brachypeltatus*. In the first mentioned the ds-3 insert immediately adjacent or in the margin of the PD, in the latter within the narrow band of striated integument. The Madagascan individuals belong to *P. a. alpinus*.

In general, all adults in populations of *P. alpinus* are females. The above mentioned male is one of the very rare exceptions. A former record of a male is one of *P. a. brachypeltatus*. It was found among more than 2500 slide-mounted adults, all extracted from a population living in Northern Germany which inhabited a small former peat ditch, now filled with rapidly growing *Sphagnum* sp. (Sphagnales) (Bartsch 1987). The water in the peat ditch was acidic, had a low ionic concentration and a sparse fauna (some few cladocerans, rotifers and testaceans). Differences between the males, from Madagascar (*P. a. alpinus*) and northern Germany (*P. a. brachypeltatus*), are the larger size, 286 µm versus 254 µm, and a higher number of pgs, namely 39 versus 20 pgs. The morphological differences between the two forms *P. a. alpinus* and *P. a. brachypeltatus* raises the question whether these are two separate species, subspecies or ecotypes? In northern Europe, *Porohalacrus a. alpinus* inhabits a wide range of substrata, slightly acidic to alkaline and even oligohaline brackish water, oligo- and mesotrophic lakes, ponds and banks of slow flowing rivers, substrata rich in microcaverns, e.g. dense colonies of small mussels (*Dreissena* sp.), colonies of sponges, bryozoans, mosses, and biofilms on vascular plants, all these habitats have a

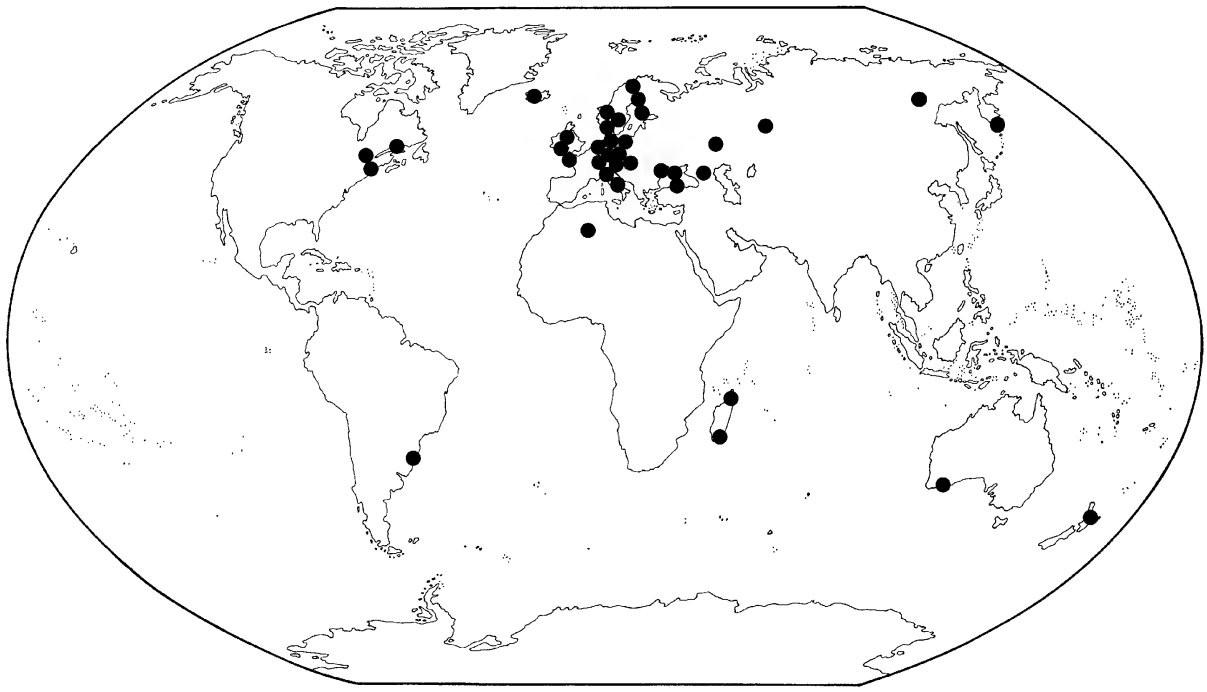

Fig. 7. Records of *Porohalacarus alpinus* (Thor, 1910) (*Porohalacarus alpinus brachypeltatus* included).

rich meio- and microfauna and -flora. In contrast, *P. a. brachypeltatus* has been taken only in strongly acidic *Sphagnum* peats with sparse associated meiofauna. Judging by the gut content of *P. a. alpinus*, namely brownish, with darker and lighter particles, these mites are carnivorous. In contrast, the gut content of *P. a. brachypeltatus* is greenish, suggesting that the mites are phytophagous. Is *P. alpinus brachypeltatus* a degenerate (impoverished) form, because of its life in an environment with low concentration of cations and meagre diet? Both molecular and experimental studies, namely rearing of the mites over several generations under different environmental conditions, may give an answer. Phenotypic plasticity in freshwater crustacea has been documented more than a century ago (Woltereck 1909), and plasticity is not restricted to arthropods, Cattau et al. (2018) recently described a rapid morphological change in a bird of prey.

Geographical distribution (Fig. 7) of both *P. a. alpinus* and *P. a. brachypeltatus* (Viets 1956; Green & MacQuitty 1987; Bartsch 2007, 2009, 2011; Tolstikov et al. 2005; Semenchenko et al. 2010; Stolbov et al. 2018; Pepato & da Silva Conceição 2019 in press):
Afrotropical Region. – Madagascar (new record);
Palaearctic Region. Europe: – Austria – Belgium – Great Britain (England, Scotland, Wales) – Denmark – Finland – France – Germany – Hungary – Iceland – Italy – Norway – Poland – Russia (Saratov—Volga Biological Station) – Sweden – Switzerland – The Netherlands – Ukraine. Northern Africa: – Algeria. Asia: – Turkey – Russia (Kamchatka, Sakha Republic, Tyumen region);
Australian Region. – Australia (Western Australia—Esperance). – New Zealand (North Island).
Nearctic Region. – United States (New Hampshire, Rhode Island). – Canada (Ontario, Quebec);
Neotropical Region. – Brazil (Rio Grande do Sul—*Porohalacarus* cf. *alpinus*).

Ropohalacarus pallidus Bartsch, 2013

Ropohalacarus pallidus Bartsch, 2013b: 80–84, figs 1a–h, 2a–g.

Collecting data. Central Madagascar, Antananarivo, Anjazorobe, River Ranonisoanavola (larger stream E from main mountain chain), 1200 m asl, 13.2°C, 0.058 mS/cm, interstitial, 23 Jul. 2001 (MD 012). South-eastern Madagascar, Fianarantsoa, Ionilahy, stream draining area Marosaro (S from River Ionilahy), 220 m, 21°C,

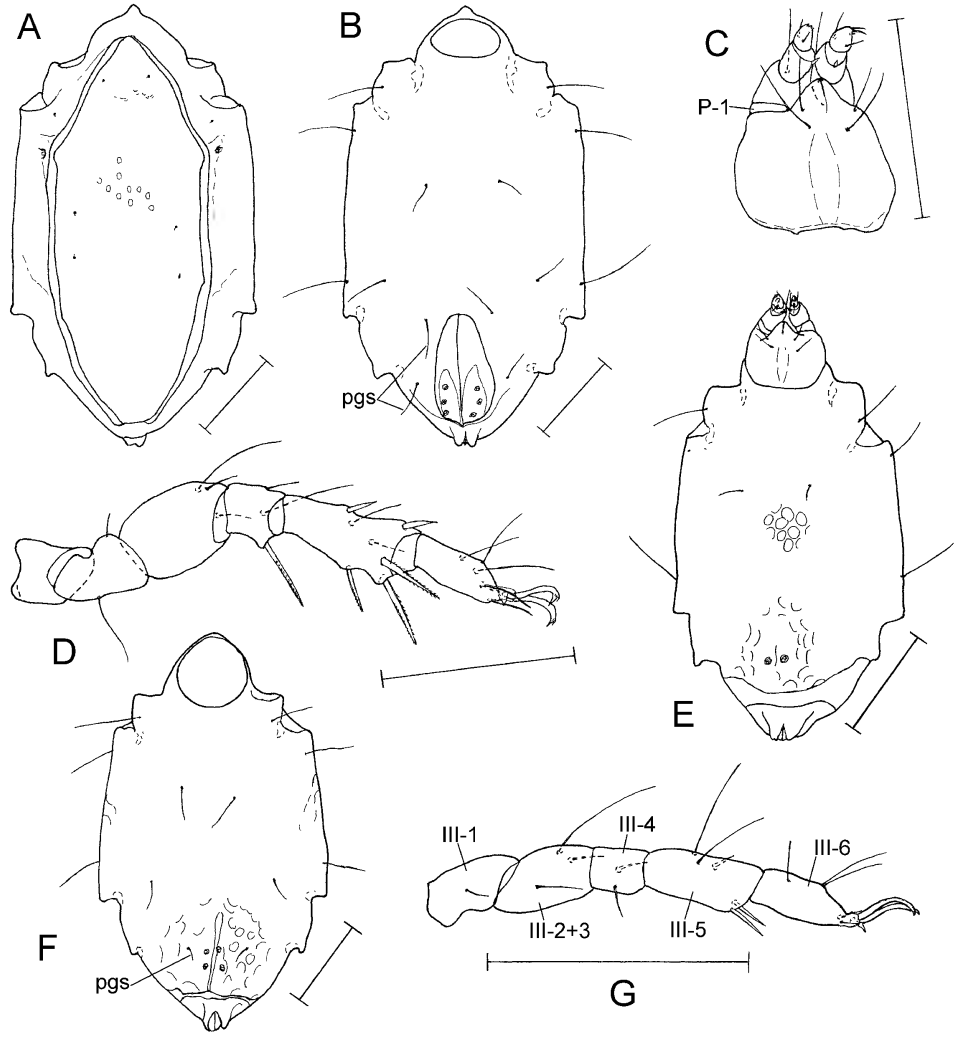

Fig. 8A–G. *Ropohalacarus pallidus* Bartsch, 2013. **A.** idiosoma, dorsal, female; **B.** idiosoma, ventral, female; **C.** gnathosoma, ventral, female; **D.** leg I, medial, female; **E.** idiosoma and gnathosoma, ventral, protonymph; **F.** idiosoma, ventral, deutonymph, **G.** leg III, lateral, larva. (Scale = 50 µm) (pgs, perigenital seta(e); P-1, first palpal segment; III-1, III-2+3, III-4, III-5, III-6, trochanter, femur, genu, tibia and tarsus of leg III).

0.072 mS/cm, 12 Aug. 2001, interstitial (MD 023). – South-eastern Madagascar, Fianarantsoa, Ionilahy, small stream crossing the railroad east from village, 200 m, 15 Aug. 2001 (MD 027). – South-eastern Madagascar, Fianarantsoa, Andrambovato, stream 3 km E from the village, upstream from the cascade, 900 m, 20 Aug. 2001 (MD 038). – Southern Madagascar, Tulear, Tsimelahy, River Antarantsa, ca 1 km upstream from village, 300 m, 20.4°C, 0.171 mS/cm, 04 Sep. 2001, interstitial (MD 058). – Tulear, Andohalela, Isaka, spring area S pass RIP 118 (km36), 700 m, 16.0–18.4°C, 0.055–0.060 mS/cm, 10 Sep. 2001, interstitial (MD 071). – Northern Madagascar, Antsiranana, Andapa, right affluent River Ambendrana downstream, large cascade, 600 m, 11 Nov. 2001 (MD147).

Short description (Fig. 8A–G). *Female*: Length 203–245 [30] µm, idiosoma pale, about 1.8 times longer than wide, its anterior and posterior part narrowed. Eye pigment lacking. AD and PD fused to an elongate dorsal shield (Fig. 8A). Ventral shield extending dorsad and including AE, PE, GA (Fig. 8B) and parts corresponding to OC. Integument of dorsal shield with delicate porosity and faint foveate ornamentation, ventral plates almost smooth. Dorsal setae very small, ds-1, ds-3 and ds-4 in dorsal shield, ds-2 in dorsal part of ventral shield. Adanal setae lacking. Gland pores lacking. Area of ventral shield

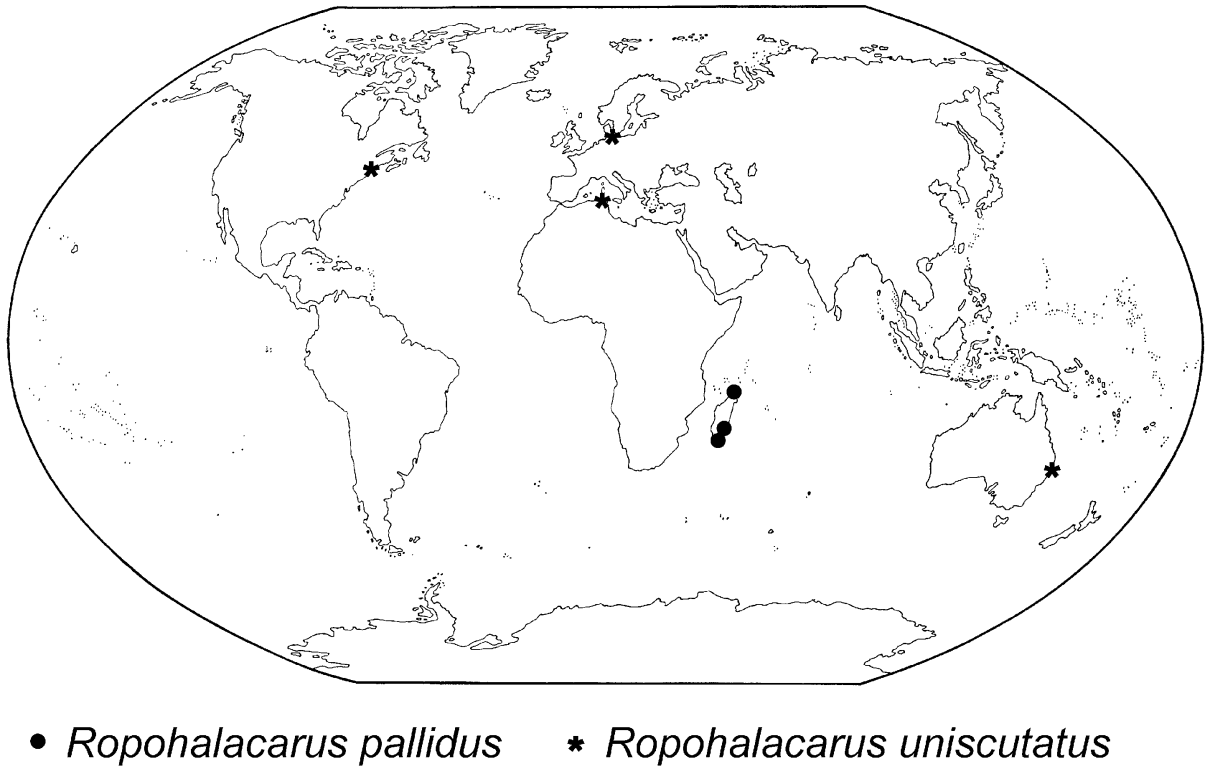

Fig. 9. Records of *Ropohalacarus pallidus* Bartsch, 2013 (black spot) and *R. uniscutatus* Bartsch, 1982 (asterisk).

representing AE with two pairs of marginal and one pair of ventral setae, areas of PE each with one marginal and one ventral seta, and that of GP with two perigenital setae. Marginal setae of idiosoma longer than ventral setae. Three pairs of genital acetabula arranged in posterior part of genital sclerites. Gnathosoma slightly wider than long (Fig. 8C). Palps four-segmented, extending beyond short, conical rostrum. Short palps and rostrum visible in dorsal aspect. Legs distinctly shorter than idiosoma (length ratio leg I:idiosoma equalling 0.5:1). Distance between apertures of pairs of legs II and III almost equal to half the length of idiosoma (in the other genera length of idiosoma more than twice the distance between these apertures). Trochanter I in one of the females studied with delicate medial seta, in general no seta present. Ventral setae on genu I and three ventral setae on tibia I bipectinate (Fig. 6D).

Male: Not present.

Juveniles: Length of deutonymph 173–226 µm [6], of protonymph 122–173 µm [3], of larva 113–128 µm [2]. Nymphs with AD and PD separated by striated integument, remnants of ocular plates and marginal part of epimeral plates fused. Ventral plates AE, PE and GP fused to a single ventral shield, no fissure between area representing AE and GP. Ventral plates delicate; ornamented with foveae. In both nymphal instars area representing AE with three pairs of setae (Fig. 8E and F). In deutonymph area representing PE with one pair of marginal and one of ventral setae (Fig. 8F) and area of GP with one pair of pgs. Protonymphal PE solely with pair of marginal setae. Larval tarsus III, just as tarsi III of following instars, with three dorsal setae, namely two fossary setae and one solenidion (Fig. 8G).

Biology. Of 32 females studied 13 (41%) were ovigerous. In general a single egg was present, its size (length x diameter) between 45 x 43 µm and 70 x 43 µm.

Remarks. As illustrated in Bartsch (2013b: fig. 2e), AD and PD of the deutonymphs, as also those of the protonymphs, are separated from each other by a narrow, transverse area of striated integument, but both deuto- and protonymphs have a ventral shield, including the anterior and posterior epimeral and the genital plate (AE, PE and GP). In contrast to Bartsch (2013b: fig. 2f, 2g), no transverse rupture was recognized in the new material studied (three deutonymphs, one protonymph). In the majority of halacarids the adults have solid exoskeletal

plates. In several species these are fused to a dorsal or ventral shield. Sometimes, though rarely, both the dorsum and venter are covered by a solid shield whereas the juveniles have the plates separated by tensible striated integument. Consequently juveniles can grow due to expansion of the striated integument between the dorsal and the ventral plates (as illustrated in *Halacarellus subterraneus* — Bartsch 1972 fig. 28A, B versus C, D and E, F versus G, H) whereas the adults can hardly increase in size. An exception is *Ropohalacarus pallidus*. In the juveniles of this species, the foveate textured integument of the ventral plates is expected to allow a slight dilatation (cf. Bartsch 2013b). Data on the thickness of the pro- and epicuticula are lacking.

No males have ever been found, neither of *Ropohalacarus pallidus* nor of the second species, namely *R. uniscutatus*, but the number of specimens studied to date is small (< 50 individuals).

Compared with other Madagascar halacarids, *R. pallidus* is in its general shape most similar to *Porohalacarus alpinus*. Distinguishing characters are: the pale idiosoma (versus prominent spots of eye pigment), the dorsal and ventral shield (versus dorsum with AD, OC and PD, venter with AE, PE and GP), the ornamentation of dorsal shield or plates, delicately foveate versus reticulated with longitudinal polygons, the position of apertures of legs III, in posterior third of idiosoma (0.7) versus in its middle (0.5).

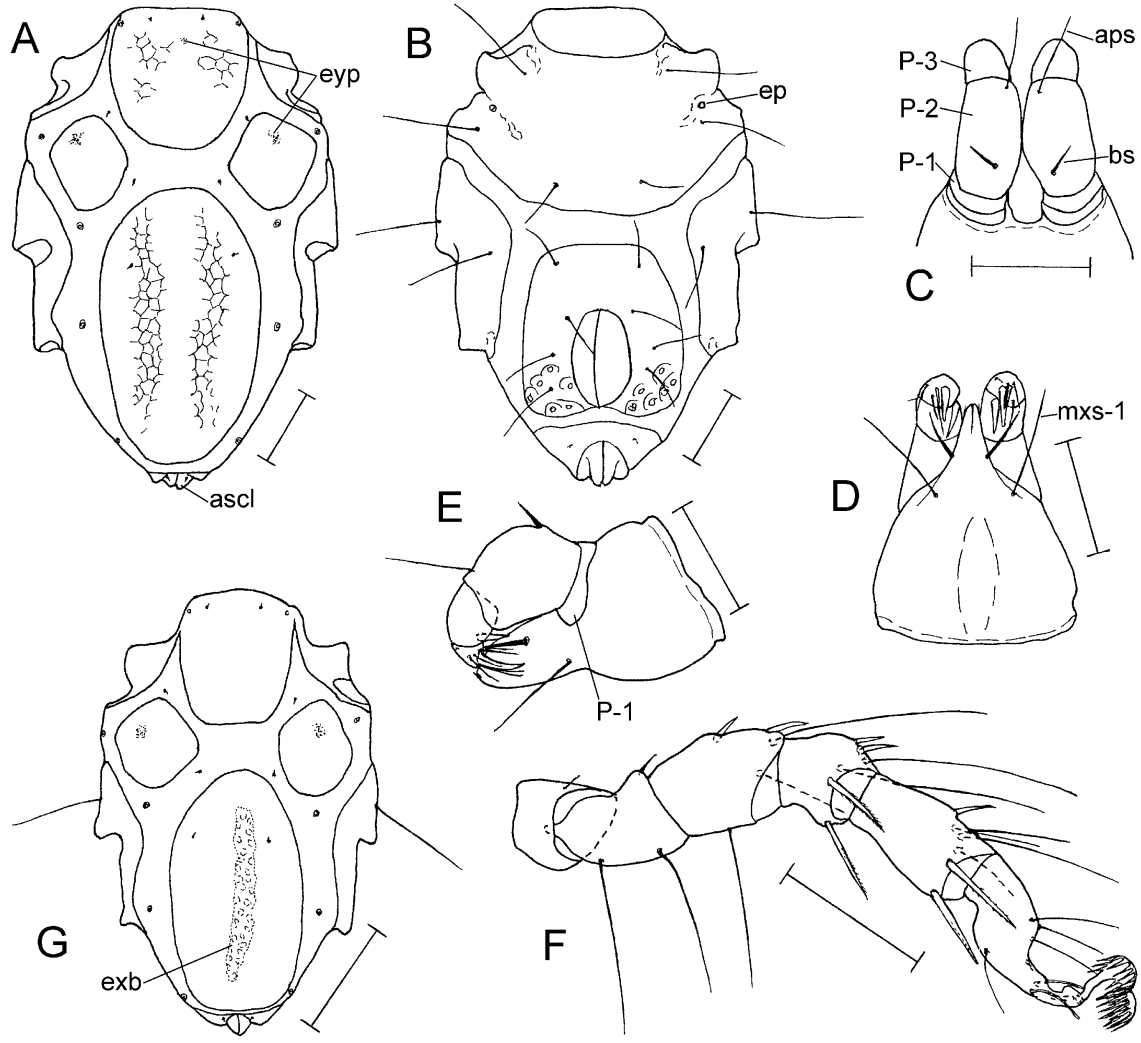

Fig. 10A–G. *Soldanellonyx monardi* Walter, 1919. **A.** idiosoma, dorsal, female; **B.** idiosoma, ventral, female; **C.** part of gnathosomal base with P-1, P-2 and P-3, female; **D.** gnathosoma, ventral, female; **E.** gnathosoma, lateral, female; **F.** leg I, ventromedial, female; **G.** idiosoma, dorsal, protonymph. (Scale = 50 µm) (aps, apical seta on second palpal segment; ascl, anal sclerite; bs, basal seta on second palpal segment; ep, epimeral pore; exb, excretory bar; eyp, eye pigment; mxs-1, basal maxillary seta; P-1, P-2, P-3, first, second and third palpal segment).

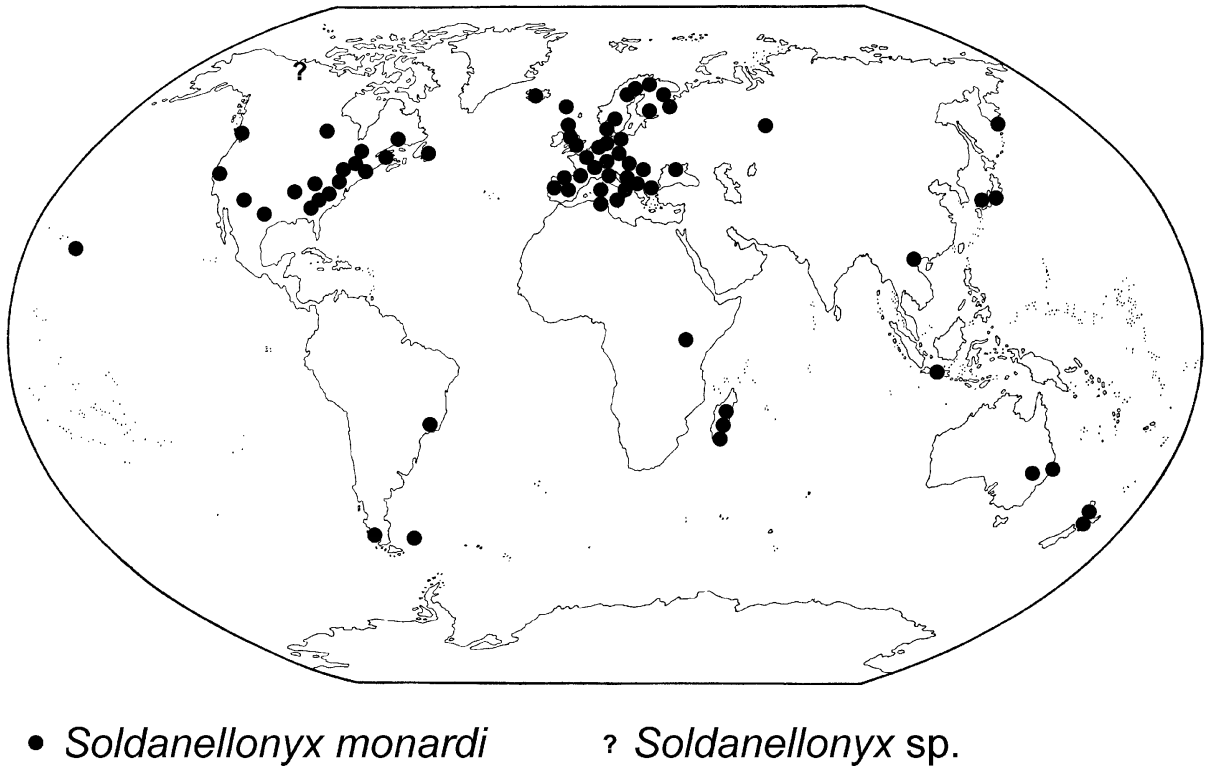

Fig. 11. Records of *Soldanellonyx monardi* Walter, 1919.

Geographical Distribution (Fig. 9):
Afrotropical Region. – Madagascar (Bartsch 2013b and present record).

***Soldanellonyx monardi* Walter, 1919**

S. monardi Walter, 1919b: 238–241, fig. 4–7.
S. monardi, Green & MacQuitty 1987: 156, fig. 65A–C; Bartsch 2006: 142, 143, fig. 5-19a–f, 2007: 82, 83, fig. 3, 2011: 502, fig. 11A–C, 2014a: 167–169, fig. 2A–K.
S. monardi sarangaensis Viets, 1929: 32–34, fig. 5–7(a, b).

Subspecies of uncertain position but expected to belong to *S. monardi* are:
S. monardi hyogoensis Imamura, 1981: 292 (described in Imamura 1959: 56, 57, fig. 2a–e).
S. monardi japonicus Imamura, 1971: 334–336, figs 2a–c, 3a–d.

Collecting data. Central Madagascar, Antananarivo, Anjazorobe, River Ranonisoanavola (larger stream E from main mountain chain), 1200 m asl, 13.2°C, 0.058 mS/cm, interstitial, 23 Jul. 2001 (MD 012). – South-eastern Madagascar, Fianarantsoa, Andrambovato, stream 3 km E from the village, upstream from the cascade, 900 m, 20 Aug. 2001 (MD 038). – Southern Madagascar, Tulear, Tsimelahy River Antarantsa, ca 1 km upstream from village, 300 m, 20.4°C, 0.171mS/cm, interstitial, 04 Sep. 2001 (MD 058). – Central Madagascar, Antananarivo, Ankaratra, Reserve Manjakatompo, left affluent of River Mahiavona, EM Mantsina, 1750 m, 14.1°C, 0.003 ms/cm, interstitial, 08 Oct. 2001 (MD 107).

Short description (Fig. 10A–G). *Female*: Length 270–335 µm [8]. With faint spots of brown eye pigment in anteromedian part of AD and anterior part of OC (Fig. 10A). AD, OC and PD with reticulate ornamentation, reticulation most distinct within pair of faint costae of PD. Pairs of glp-1 to glp-5 and ds-1 to ds-4 as illustrated, ds-5 lacking, ds-6 on anal cone. Delicate punctation of ventral plates presenting reticulate pattern. AE, PE and GP separated. AE with pair of epimeral pores (Fig. 10B). Each PE with one ventral and lateral but no dorsal seta. Gnathosoma somewhat wider than long (Fig. 10D). Pair of palps attached dorsally, distance between P-1 less than their width (Fig. 10C). P-2 somewhat flattened, length 1.3 times the height (Fig. 10E); basal seta on P-2 short; spiniform, distal seta long and slender. P-3 with large me-

dial spine, its length 0.9 of that of P-3. P-4 ending with a similar wide spine. Legs shorter than idiosoma, length of legs I and IV about 0.6 and 0.7 times that of idiosoma, respectively. Length of telofemur I 1.5 times the height. In addition to long, slender setae, telofemur, genu and tibia of leg I with 2, 2 and 1 short and spiniform dorsal setae and 0, 2, 2 long ventral spines, respectively. Pair of ventral spines on genu I distinctly, on tibia I faintly bipectinate. Claws I with solid, mushroom-like arranged tines (Fig. 10F), tines on claws on following tarsi in J-shaped arrangement.

Male: Not present.

Juveniles: Length of deuto-, protonymphs and larvae 205–285 [8], 180–255 [7] and 143–148 µm [2], respectively.

Biology. Of eight females studied six held eggs. Size of eggs 10 x 10 to 40 x 45 µm (length x diameter). If present, the excretory material is in form of small, brown globuli. These are concentrated within a rod-like structure (Fig. 10G).

Remarks. *Soldanellonyx monardi* is presently the only *Soldanellonyx* species recorded from the Afrotropics. *Soldanellonyx chappuisi* Walter, 1917 and *S. visurgis* Viets, 1959, as *S. monardi* reported from several continents, have as yet not been taken but are expected to be found in future studies in Africa or the Afrotropical region. *Soldanellonyx chappuisi* and *S. visurgis* have, in contrast to *S. monardi*, more slender telofemora I (length more than 1.5 times the height), four ventral bristles or spines on tibia I (versus two), more slender and longer P-2 (length more than twice the height) and the two dorsal setae on P-2 are similar-sized (versus basal seta less than half the length of distal seta). In addition, no epimeral pores are seen in *S. chappuisi* and S. *visurgis* but these are present in *S. monardi*.

Another six *Soldanellonyx* species are described, one species has been collected in both southern Japan and Kamchatka, each one of the others from a single geographical region, four from Japan, one from the Lake Baikal.

In *Soldanellonyx monardi*, as also in *S. chappuisi* and *S. visurgis*, males are extremely rare or absent. Those recorded by Sokolov (1952), Efford (1959) and Imamura (1981) need confirmation. The author expects the males of *S. monardi* to differ from females by a high number (>20) of pgs arranged around the GO and, of course, the presence of the spermatopositor. Slight differences in the outline of the GA, as described by Sokolov (1952) and Imamura (1981), are commonly found in females. Sokolov (1952: fig. 91,4) presented an illustration of a male GA with a slightly larger number of genital acetabula (11–12 pairs) and pgs (5–6 pairs) but else similar to that of females, the typical spermatopositor is not illustrated. Imamura (1981) described the 'penis skeleton' as having four hook-shaped claws; the number of the genital acetabula is similar to that of females. Hook-shaped claws on the spermatopositor are else unknown in halacarid males and those mentioned by Imamura (1981) may represent the genital spines of an ovipositor. Efford (1959) did not present any morphological details.

Geographical distribution (Fig. 11) (of *S. monardi* and its subspecies) (Fig. 8) (Bartsch 2008a, 2011, 2014a; Tolstikov et al. 2005; Pešić et al. 2010; Stolbov et al. 2018; Pepato & da Silva Conceição, in press):

Afrotropical Region. – Kenya – Madagascar;

Palaearctic Region. Europe: – Austria – Belgium – United Kingdom (England, Northern Ireland, Scotland, Wales) – Bulgaria – Crimea – Croatia – Denmark – Faeroerne – Finland – France – Germany – Hungary – Iceland – Italy – Luxemburg – Macedonia – Monte Negro – Portugal – Romania – Russia (Karelia, Kola Peninsula, Lake Onega) – Switzerland – Spain – Sweden – The Netherlands. Northern Africa: – Tunisia. Asia: – Japan – Russia (Kamchatka, Tyumen region);

Oriental Region. – Indonesia (Java) – Vietnam;

Australian Region. – Australia (New South Wales, Queensland). – New Zealand (North Island);

Pacific Islands. – Hawaiian Islands;

Nearctic Region. – Canada (British Columbia, Manitoba, New Brunswick, Newfoundland, Ontario, Quebec). – United States (Alabama, Arizona, California, Georgia, Indiana, Missouri, New Hampshire, New York, North Carolina, Missouri, Oregon, Pennsylvania, Rhode Island, Texas, Tennessee, Virginia). The *Soldanellonyx* species, by Vinke (2013) mentioned from the Northwest Territories (Canada), may belong to *S. monardi* (in Fig. 11 marked by a question mark);

Neotropical Region. – Brazil (Sao Paulo) – Chile (Magallanes) – Falkland Islands (Malvinas).

DISCUSSION

Biogeography

The halacarid species extracted from shallow water sandy deposits at the banks of streams and creeks on Madagascar belong to six species in five genera. Considering that the knowledge regarding the freshwater halacarid fauna of the world is very sparse, it is striking that none of the genera is restricted to Madagascar or to the Afrotropical Region, all are cosmopolitans. At species level, a single one (*Ropohalacarus pallidus*) is at present only known from Madagascar, but this does not mean that the species is endemic since no similar habitats have been studied in adjacent parts of Africa. The three species *Lobohalacarus weberi*, *Porohalacarus alpinus* and *Soldanellonyx monardi* are the ones generally found in the course of similar studies in northern Europe, North America and

New Zealand (Husmann & Teschner 1970, Bartsch 2007, 2011). The three species are spread on all continents except for Antarctica from where no adequate substrata have been studied in respect to their freshwater halacarid fauna. The two *Limnohalacarus* species taken on Madagascar are wide-spread, too. Since most *Limnohalacarus* species have been found in warm-temperate and tropical regions, these may avoid cold-temperate waters. One exception, *Limnohalacarus wackeri* (Walter, 1914) is recorded from northern European and Asian waters, from southern Finland and Kamchatka, respectively (Paasivirta 1975; Tolstikov et al. 2005).

Madagascar, as well as New Zealand, is known to have a unique water mite fauna (Gerecke 2004; Sirvid et al. 2011). Gerecke (2004) presented a list of Hydrachnidia, collected on Madagascar, which included 63 species. Of these, 35 (or 56%) had only been taken on Madagascar, and 24 (or 38%) on both Madagascar and Africa; only four species (or 6%) proved to be wide-spread (Gerecke 2004). Since then more Madagascan species have been described (Goldschmidt 2008; Pešić et al. 2013). Similar, the New Zealand mite fauna is known to include a very high number of endemisms; in many well studied mite groups, terrestrial as well as aquatic mites, 80 % of the species and 35 of the 59 (59 %) of the freshwater genera are expected to be restricted to New Zealand (Sirvid et al. 2011). Because of the low reproduction rate of halacarids, absence of dispersal instars but unusual wide geographical distribution of not just one but several more or less syntopic living species, Bartsch (1996, 2007) expects these species to have colonized and spread on Pangea since the Mesozoic or even Pre-Mesozoic. Minor morphological differences between populations are assumedly due to phenotypic plasticity and no evidence of cryptic speciation.

Limnohalacarus: Characters not or rarely observed in other halacarid genera

Species of the genus *Limnohalacarus* demonstrate two characters which are either restricted to this genus or only rarely found in other halacarid genera. Unique is that the eggs are fixed to the basal part of the tibiae IV (Viets 1940; Ramazotti & Nocentini 1960; Petrova 1966; Bartsch 1999) but the oviposition has not been observed. Up to 9 eggs, or their remnants, can be found per leg (Bartsch 1999). The embryos in the eggs are often in different states of development. In a population of *L. wackeri* from northern Italy, the development of the eggs took about one month (Ramazotti & Nocentini 1960). In general, halacarids deposit their eggs via the ovipositor into a substratum (Teschner 1963; Kirchner 1969; Bartsch 1972), either singly or in clusters. When at rest, the ovipositor is retracted and in most halacarid females it extends internally slightly or distinctly beyond the anterior margin of the genital foramen. The outline of the ovipositor and its genital spines are at least partly visible through the genital plate. The extruded ovipositor ends with genital spines. In some genera these spines are more or less spiniform, in others palmate, either faintly or distinctly sclerotized (cf. Bartsch 2015). In contrast to the majority of halacarid species, the ovipositor of *Limnohalacarus novus* is short and narrow (LxW 74 x 10 µm), the 1–2 µm-long genital spines at the end of the ovipositor are very faintly sclerotized, they arise from minute papillae.

Another detail often found in *Limnohalacarus* species is the combination of an ovoid, somewhat flattened body with accumulated excretory material, and small anal sclerites. Such an excretory body is already present in larvae but is most conspicuous in adults (Walter 1914; Petrova 1966; Ramazotti & Nocentini 1960; Pepato & Dos Santos 2015). In most of the other halacarid species, in larvae, nymphs and adults, the waste products are concentrated within a dorsomedian bar (cf. *Soldanellonyx monardi*—Fig. 10G; *Isobatrus uniscutatus* (Viets, 1939)—Bartsch 2014b: fig. 1). The length of the bar, if present, can correspond to about half or almost two-thirds of the idiosomal length, it is filled with white or light brown granulated material. The 'light mesial line', mentioned by Johnston (1836) in the description of *Thalassarachna basteri* (Johnston, 1836), and the 'dark line' in *Lohmannella falcata* (Hodge, 1863), described by Hodge (1863), may represent such bars. Halacarids have the excretory organ dorsal to the gut (Thomae 1926), defecation is through the anus which is guarded by the anal sclerites. Anatomical details in *Thalassarachna basteri* have been studied by Thomae (1926).

The presence of ovoid excretory bodies, in *Limnohalacarus novus* distinctly stratified, is not restricted to *Limnohalacarus* species but documented also from other halacarid genera. Examples are *Halacarus excellens* Lohmann, 1907 and *Rhombognathus amplus* Bartsch, 2013 (Bartsch 2010, 2013c) as well as other prostigmatid mite families, e.g. the Cunaxidae (Kielczewski & Wisniewski 1977). In halacarid species with such an excretory body the anal sclerites are unusual small, just as in *L. novus*. More species with small anal sclerites are *Bathyhalacarus anomalous* Bartsch, 2005, *Rhombognathus bulbosus* Bartsch, 2005, *R. cyrtonotus* Bartsch, 2000, *R. delicatulus* Bartsch, 2000 (Bartsch 2000c, 2005a, b) but in individuals of these species no ovoid bodies with excretory material were found. However, the number of mites studied is very small. At present it seems that halacarid species with a large ovoid excretory body (20–50 % of idiosomal length) have small anal sclerites, though not all mites with small anal sclerites have such an ovoid body.

Little is known about feeding, almost nothing about digestion and defecation in halacarid mites. Most halacarids, marine as well as freshwater species, are expected to be carnivorous. *Limnohalacarus wackeri*,

for example, could be reared with a diet of small ciliates, *Lobohalacarus weberi* with pieces of oligochaetes (Teschner 1963; Ramazotti & Nocentini 1960). Larvae are known to show an excretory bar or ovoid body soon after commencement of feeding (Kirchner 1969; Ramazotti & Nocentini 1960). Rate, periods and frequency of defecation are not known. A general idea may give the studies by Bowman (2017a, b) who examined the feeding of the mesostigmatid *Pergamasus longicornis* (Berlese, 1906), a carnivorous species as *Limnohalacarus*, but terrestrial and with a length of almost 1300 µm distinctly larger than *Limnohalacarus*. In *P. longicornis* up to three weeks may be needed to clear the idiosoma of excretory material (Bowman 2017a, b).

Among halacarids most species have excretory bars, only a small number has ovoid bodies with concentrically arranged layers (e.g. *Rhombognathus amplus*). Among the few specimens studied of the latter species, collected in Singapore mangroves, each following instar had an excretory body almost similar or larger in size than that of the preceding stage. The length of the idiosoma (in parentheses) and LxW data of the excretory body are in protonymphs (209–235 µm) about 37 x 25 µm, in deutonymphs (242–284 µm) 37–75 x 25–30 µm, in tritonymphs (245–354 µm) 127 x 30 µm, and in adults (364–415 µm) 110–182 x 62–77 µm. For critical examination of taxonomic details, halacarid mites have to be cleared, i.e., the body content has to be removed. In *R. amplus* the stiff excretory body could only with difficulty be pressed through the camerostome, though the size of the latter (LxW about 70 x 100 µm) is much larger than that of the anal slit (length about 20 µm). How can such large excreta pass through the small anal opening? Do the mites accumulate excretory material during their lives, from the larval to the adult stage? This seems to be unlikely; the amount of excreta produced in the course of the mite's life is expected to be much larger than that enclosed in the ovoid body. Most halacarids studied have a life span of about 15 months, *Limnohalacarus* up to 24 months (Ramazotti & Nocentini 1960; Bartsch 1972, 1987), the major part takes the adult stage. About one quarter of the *Limnohalacarus novus* females studied had no excretory bodies. This quarter included stages from recently hatched to cocoon-carrying females, and accordingly we can expect that the small anal sclerites do not prevent defecation. Since quiescent or moulting stages were not represented in the samples, we do not know if at least partly the mites can defecate during or immediately after moulting, as long as the integument is not hardened yet.

The two just mentioned species differ in their life style which in turn will influence digestion and defecation. *Rhombognathus amplus* is phytophagous and restricted to the upper tidal zone, several hours a day emerged. The delicate algal film inhabited quickly desiccates. The mites studied were collected during low tide, consequently they were dehydrated and that certainly had an influence on the compactness of the waste products and the defecation. In contrast, *Limnohalacarus* species are carnivorous and live in an at least constantly waterlogged habitat. Feeding and metabolic activities are not hampered by desiccation and hence the wastes may be elastic enough to be pressed through the small and narrow anal slit.

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REFERENCES

André HM, N'Dri JK (2012) Bréviaire de taxonomie des acariens. Abc Taxa, la série de manuels dédiés aux renforcements des capacités en taxonomie et en gestion des collections 13: 1–184

Bader C (1968) Wassermilben aus Zentralafrika. Annales du Musée Royal de l'Afrique Central, Série A, Zoologie 163: 1–50

Balian EV, Segers H, Lévêque C, Martens K (2008) An introduction to the freshwater animal diversity assessment (FADA) project. Hydrobiologia 595: 3–8

Bartsch I (1972) Ein Beitrag zur Systematik, Biologie und Ökologie der Halacaridae (Acari) aus dem Litoral der Nord- und Ostsee. I. Systematik und Biologie. Abhandlungen und Verhandlungen des Naturwissenschaftlichen Vereins zu Hamburg, Neue Folge 16: 155–230

Bartsch I (1973) *Porohalacarus alpinus* (Thor) (Halacaridae, Acari), ein morphologischer Vergleich mit marinen Halacariden nebst Bemerkungen zur Biologie dieser Art. Entomologisk Tidskrift 94: 116–123

Bartsch I (1982) Halacariden (Acari) im Süßwasser von Rhode Island, USA, mit einer Diskussion über Verbreitung und Abstammung der Halacaridae. Gewässer und Abwässer 68/69: 41–58

Bartsch I (1987) Zur Biologie, Ökologie und Verbreitung der süßwasserbewohnenden Halacaride *Porohalacarus alpinus* (Acari). Archiv für Hydrobiologie 111: 83–93

Bartsch I (1995) A new subspecies of the freshwater halacarid mite *Lobohalacarus weberi* (Romijn and Viets) (Halacaridae, Acari) from a Southern Atlantic Ocean Island. Annals of the Cape Provincial Museums, Natural History 19: 171–180

Bartsch I (1996) Halacarids (Halacaroidea, Acari) in freshwater. Multiple invasions from the Paleozic onwards? Journal of Natural History 30: 67–99

Bartsch I (1999) Two new freshwater mites of the genus *Limnohalacarus* (Halacaridae: Acari) from Australia. Records of the Western Australian Museum 19: 443–450

Bartsch I (2000) Rhombognathinae (Acari: Halacaridae) from the Great Barrier Reef, Australia. Memoirs of the Queensland Museum 45: 165–203

Bartsch I (2005a) Halacaridae from the depths of Western Antarctica (Arachnida: Acari). Senckenbergiana Biologica 85: 31–41

Bartsch I (2005b) Upper littoral rhombognathines (Acari: Halacaridae) of Singapore: description of three new species. Cahiers de Biologie Marine 46: 273–287

Bartsch I (2006) 5. Acari: Halacaroidea. Pp. 113–157 in Gerecke R (ed.) Süßwasserfauna von Mitteleuropa Vol. 7,2-1, Elsevier, Spektrum Akademischer Verlag, München

Bartsch I (2007) Freshwater Halacaridae (Acari) from New Zealand rivers and lakes, with notes on character variability. Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut 104: 73–87

Bartsch I (2008a) Freshwater halacarid mites (Halacaridae: Prostigmata: Acari) from Tunisia, three new records and notes on geographical distribution of these species. Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg 15: 15–27

Bartsch I (2008b) Halacarid mites (Acari) in a freshwater influenced beach of North Stradbroke Island, Moreton Bay, Queensland. Pp 117–130 in Davie PJF, Phillips JA (eds) Proceedings of the Thirteens International Marine Biological Workshop. The Marine Fauna and Flora of Moreton Bay, Queensland. Memoirs of the Queensland Museum 54 (1)

Bartsch I (2009) Checklist of marine and freshwater halacarid mite genera and species (Halacaridae: Acari) with notes on synonyms, habitats, distribution and descriptions of the taxa. Zootaxa 1998: 1–170

Bartsch I (2010) *Halacarus excellens* Lohmann, 1907 (Acari: Halacaridae), a new record a century later, re-description and notes on this and other Antarctic halacarid species. Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg 15: 157–170

Bartsch I (2011) North American freshwater Halacaridae (Acari): literature survey and new records. International Journal of Acarology 37: 490–510

Bartsch I (2013a) The freshwater halacarid genus *Limnohalacarus* (Halacaridae, Acari), species diagnoses, distribution and relationship. Verhandlungen des naturwissenschaftlichen Vereins in Hamburg 47: 185–220

Bartsch I (2013b) Freshwater halacarid mites (Acari: Halacaridae) from Madagascar. New records and description of a new species. Acarologia 53: 77–87. DOI: 10.1051/acarologia/20132080

Bartsch I (2013c) Upper littoral rhombognathines (Acari: Halacaridae) from Singapore: description of a new species. Acarologia 53: 305–313 DOI: 10.1051/acarologia/20132097

Bartsch I (2013d) Arachnida-Halacaridae checklist. World checklist of freshwater Halacaridae species. http://fada.biodiversity.be/group/show/32

Bartsch I (2014a) New records of freshwater Halacaridae (Acari) from the Oriental Region and a supplementary description of *Soldanellonyx visurgis*. International Journal of Acarology 40(2): 165–173

Bartsch I (2014b). Die Meeresmilbe *Isobactrus uniscutatus* (Acari: Halacaridae), ein "Europäer" in australischen Gewässern. Verhandlungen des Naturwissenschaftlichen Vereins zu Hamburg, Neue Folge 48: 177–188

Bartsch I (2015) The genital area of Halacaridae (Acari), life stages and development of morphological characters and implication on the classification. Zootaxa 3919: 201–259

Berlese A (1906) Monographia del genere Gamasus Latr. Redia 3: 65–304

Bowman CE (2017a) Modelling Malpighian tubule crystals within the predatory soil mite *Pergamasus longicornis* (Mesostigmata: Parasitidae). Experimental and Applied Acarology 72: 35–59

Bowman CE (2017b) Gut contents, digestive half-lives and feeding state prediction in the soil predatory mite *Pergamasus longicornis* (Mesostigmata: Parasitidae). Experimental and Applied Acarology 73: 11–60

Cattau CE, Fletcher RJ Jr, Kimball RT, Miller CW, Kitchens WM (2018) Rapid morphological change of a top predator with the invasion of a novel prey. Nature Ecology & Evolution 2 (1):108–115. DOI: 10.1038/s41559-017-0378-1

Chatterjee T, Chang CY (2005) A new species of *Limnohalacarus* (Acari: Halacaridae) from India. Bulletin. Institut Royal des Sciences Naturelles de Belgique, Entomologie 75: 23–27

Efford I (1959) The distribution of three British Porohalacaridae (Acari). Entomologist's monthly Magazine 95: 84

Fritz KM, Feminella JW (2011) Invertebrate colonization of leaves and roots within sediments of intermittent Coastal Plain streams across hydrologic phases. Aquatic Sciences 73 (4): 459–469

Gerecke R (2004) The water mites of Madagascar (Acari, Hydrachnidia): a revised list completed by original material conserved at the Muséum national d'Histoire naturelle, Paris. Zoosystema 26 (3): 393–418

Goldschmidt T (2008) Taxonomical, ecological and zoogeographical studies on anisitsiellid water mites (Acari: Hydrachnidia: Anisitsiellidae Koenicke, 1910) from Madagascar. Zootaxa 1954: 1–120

Green J (1984) The occurence of *Limnohalacarus* (Acari: Halacaridae) in Lake No, White Nile. Hydrobiologia 110: 135–136

Green J, Corbet SA, Betney E (1974) Ecological studies on crater lakes in West Cameroon. Debundsha Lake. Journal of Zoology, London 173: 199–223

Green J, MacQuitty M (1987) Halacarid Mites. Synopses of the British Fauna (New Series) 36: 1–178

Harvey M (1988) A new species of *Lobohalacarus* from Australia (Chelicerata: Acarina: Halacaridae). Memoirs of the Museum of Victoria 49: 363–365

Husmann S, Teschner D (1970) Ökologie, Morphologie und Verbreitungsgeschichte subterraner Wassermilben (Limnohalacaridae) aus Schweden. Archiv für Hydrobiologie 67: 242–267

Hodge G (1863) Contributions to the marine zoology of Seaham Harbour. On some undescribed marine Acari. Transactions of the Tyneside Naturalists' Field Club 5(4): 298–303

Imamura T (1959) Water-mites (Hydrachnellae and Porohalacaridae) from the subterranean waters of Akiyoshidae Karst, Japan. Japanese Journal of Zoology 12: 251–255

Imamura T (1970) The fauna of the insular lava caves in West Japan. II. Porohalacaridae (Acari). Bulletin of the National Science Museum, Tokyo 13: 455–458

Imamura T (1971) The fauna of the lava lakes around Mt. Fuji-san. V. Limnohalacarinae (Acari). Bulletin of the National Science Museum, Tokyo 14: 333–336

Imamura T (1981) Fresh-water halacarid mites from Oahu Island, Hawaii. Annotationes Zoologicae Japonensis 54: 287–292

Jankovskaja AI (1967) [On the fauna of ground-waters of middle Asia. I. Hydracarina of the fam. Porohalacaridae (Acari) in the ground-waters of the wells in Kizylkum desert.] Trudy Zoologičeskogo Instituta, Akademija Nauk SSSR, Leningrad 43: 109–117 (In Russian)

Johnston G (1836) Illustrations in British zoology. Magazine of Natural History 9 (63): 353–357

Kielczewski B, Wisniewski J (1977) Irregularities in the guanine expel in the mite *Cunaxa setirostris* (Herm) (Acarina, Cunaxidae). Acarologia 19: 619–621

Kirchner W-P (1969) Zur Biologie und Ökologie von *Halacarus basteri basteri* Johnson 1836 (Acari, Trombidiformes). Oecologia (Berlin) 3: 56–69

Lohmann H (1907) Über einige faunistische Ergebnisse der Deutschen Südpolar-Expedition unter besonderer Berücksichtigung der Meeresmilben. Schriften des Naturwissenschaftlichen Vereins für Schleswig-Holstein 14: 1–14

Ojeda M, Rivas G, Álvarez F (2016) First record of the genus *Limnohalacarus* (Acari: Halacaridae) from Mexico (*Primer registro del género* Limnohalacarus *(Acari: Halacaridae) de México*). Revista Mexicana de Biodiversidad 87: 1131–1137

Paasivirta L (1975) Distribution and abundance of Halacaridae (Acari, Trombidiformes) in the oligotrophic lake Pääjärva, Southern Finland. Annales Zoologici Fennici 12: 119–125

Pepato AR, Dos Santos Costa SG (2015) New records of the genus *Limnohalacarus* (Halacaridae, Trombidiformes) from southern Brazil. Check List The Journal of Biodiversity Data 11 (1): Article 1500. www.biotaxa.org/cl

Pepato AR, da Silva Conceição PH (2019) Chapter 17 Halacaridae. (in press) in Thorp JH (ed.) Thorp and Covich's Freshwater Invertebrates, Fourth Edition, Volume III, Keys to Neotropical and Antarctic Fauna. Academic Press, 672 pp.

Pešić V, Smit H, Datry T (2010) New records of water mites (Acari: Hydrachnidia, Halacaroidea) from Patagonia (Chile). Systematic & Applied Acarology 15: 151–160

Pešić V, Cook D, Gerecke R, Smit H (2013) The water mite family Mideopsidae (Acari: Hydrachnidia): a contribution to the diversity in the Afrotropical region and taxonomic changes above species level. Zootaxa 3720: 1–75

Petrova A (1966) Deux nouveaux halacariens d'Israël – *Limnohalacarus capernaumi* n. sp. et *Lohmannella heptapegoni* n. sp. International Journal of Speleology 2: 355–362

Ramazotti G, Nocentini AM (1960) Porohalacaridae (Hydracarina) del Lago di Mergozzo. Memorie dell'Istituto Italiano di Idrobiologia Dott. Marcode Marchi 12: 185–200

Romijn G, Viets K (1924) Neue Milben. Archiv für Naturgeschichte 90: 215–225

Schwoerbel J (1955) Über einige Porohalacariden (Acari) aus dem südlichen Schwarzwald. Zoologischer Anzeiger 155: 146–150

Semenchenko KA, Abé H, Boeskorov GG (2010) New data on the water mite fauna (Acari, Hydrachnidia, Halacaroidea) of the Sakha Republic (Yakutia). Entomological Review 90 (2): 218–229

Sirvid PJ, Zhang Z-Q, Harvey MS, Rhode BE, Cook DR, Bartsch I, Staples DA (2010) Phylum Arthropoda Chelicerata horseshoe crabs, arachnids, sea spiders. Chapter 6. Pp. 50–89 in Gordon DP (ed.) New Zealand Inventory of Biodiversity 2 (6)

Sokolov II (1952). Vodjanye klešči. II. Halacarae. Fauna SSSR 5: 1–201

Stolbov VA, Popova VV, Sheikin SD, Tupitsyn SS (2018) Water mites (Acariformes: Hydrachnidia, Halacaroidea) of bogs of Western Siberia (Russia). Ecologica Montenegrina 18: 102–109

Teschner D (1963) Die Biologie, Verbreitung und Ökologie der Grundwassermilbe Lobohalacarus weberi quadriporus (Walter, 1947), Limnohalacaridae Acari. Archiv für Hydrobiologie 59: 71–102

Thomae H (1926) Beiträge zur Anatomie der Halacariden. Zoologische Jahrbücher, Abteilung 2, 47: 155–190

Thor S (1910) Die erste norwegische Süßwasserform der Halacariden. Zoologischer Anzeiger 36: 348–351

Thor S (1922) Neue Acarina-Formen aus meinen älteren Sammlungen, nebst Bemerkungen über Arten, Gattungen und Familien. Nyt Magasin for Naturvidenskaberne 61: 91–118

Tolstikov AV, Vvedenskaya TL, Stolbov VA (2005) Preliminary data on the fauna of fresh-water mites (non-Parasitengona) of the Kamchatka Peninsula. Vladimir Ya. Levanidov's Biennial Memorial Meetings 3: 309–311 (In Russian, with English Summary)

Viets K (1927) Mitteilung über das Vorkommen von Halacariden in der Kiemenhöhle des Flußkrebses. Verhandlungen. Internationale Vereinigung für theoretische und angewandte Limnologie 3: 460–473

Viets K (1929) Über Süßwasser-Halacaridae. (Vierte Mitteilung über Hydracarina von den Sunda-Inseln.) Zoologischer Anzeiger 86: 27–34

Viets K (1939) Meeresmilben aus der Adria (Halacaridae und Hydrachnellae, Acari). Archiv für Naturgeschichte (Neue Folge) 8: 518–550

Viets K (1940) Zwei neue Porohalacaridae (Acari) aus Südamerika. Zoologischer Anzeiger 130: 191–201

Viets K (1956) Die Milben des Süßwassers und des Meeres. Katalog der Halacaridae. Meeresmilben, II. Abschnitt. Pp. 641–870 in Viets K (ed.) Die Milben des Süßwassers und des Meeres. Hydrachnellae et Halacaridae, Acari. VEB Fischer Verlag, Jena

Viets K (1959) Die aus dem Einzugsgebiet der Weser bekannten oberirdisch und unterirdisch lebenden Wassermilben. Veröffentlichungen des Instituts für Meeresforschung in Bremerhaven 6: 303–513

Vinke K (2013) An investigation of sampling protocols and community involvement in stream biomonitoring in the Sahtu Settlement Area, Northwest Territories. Master of Science Thesis, MS00449, University of Prince Edward Island (Canada). 293 pp. ISBN: 9780499004499

Walter C (1914) Notizen über die Süßwasserformen der Halacariden nebst Beschreibung einer neuen Art. Archiv für Hydrobiologie 9: 279–285

Walter C (1917) Schweizerische Süßwasserformen der Halacariden. Revue Suisse de Zoologie 25: 411–423

Walter C (1919a) Hydracarinen aus den peruanischen Anden und aus Brasilien. Revue Suisse de Zoologie 27: 19–59

Walter C (1919b) Schweizerische Süßwasserformen der Halacariden. Revue Suisse de Zoologie 27: 235–242

Walter C (1935) Hydracarina. In Voyage de Ch. Alluaud et P.A. Chappuis en Afrique Occidentale française (Déc. 1930–Mars 1931). Archiv für Hydrobiologie 28: 69–136

Walter C (1947) Neue Acari (Hydrachnellae, Porohalacaridae, Trombiidae) aus subterranen Gewässern der Schweiz und Rumäniens. Verhandlungen der Naturforschenden Gesellschaft in Basel 58: 146–238

Walter C, Bader C (1952) Mission scientifique de l'Omo. – Hydracarina. Mémoires du Muséum Nationale d'Histoire Naturelle, Série A, Zoologie 4: 87–236

Woltereck R (1909) Weitere experimentelle Untersuchungen über Artveränderung, speziell über das Wesen quantitativer Artunterschiede bei Daphniden. Verhandlungen der deutschen zoologischen Gesellschaft 19: 110–172

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Reliability, completeness and improvement of our knowledge on Germany's parasitoid wasp fauna – a case study in Chalcidoidea (Hymenoptera)

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Abstract. Parasitoid wasps account for a significant proportion of Germany's insect fauna. Detailed and accurate knowledge on this fauna is crucial in order to conduct thorough studies in, for example, ecology and conservation, and to adequately meet the challenges related to the recently reported dramatic biodiversity loss. However, our knowledge on many species-rich insect groups is error-prone and fragmentary. In this study, we evaluate our knowledge on the German fauna of Chalcidoidea, one of the most species-rich parasitoid wasps groups, for reliability and completeness. We show that more than one third of the 1,939 recorded chalcidoid species are known only from a single citation/record, and usually records are neither detailed nor vouchered. More than two thirds of the species have never been taxonomically revised. We also found that there are 344 species recorded from neighboring countries of Germany which might also occur in Germany. In this study, we report the first records from Germany of *Calosota aestivalis* Curtis, 1836 (Chalcidoidea: Eupelmidae: Calosotinae) and *Torymus cupreus* (Spinola, 1808) (Chalcidoidea: Torymidae: Toryminae). Both records are the result of close collaboration between citizen scientists and professional entomologists, and both records include detailed collecting information, life images and voucher specimens. We note that such collaboration is very valuable to increase our knowledge on previously widely neglected taxa. The necessary strategic goal of a well-known German insect fauna, however, will only be achieved by strongly intensifying the research on biodiversity and taxonomy of all insect taxa.

Keywords. Biodiversity; Chalcidoidea; Germany; parasitoid wasps.

INTRODUCTION

Approximately 33,000 insect species have been listed to occur in Germany (Völkl et al. 2004), and this number is frequently used in scientific or popular publications, comments or surveys. A significant proportion of them belong to so-called understudied taxa. Taxa in need of more study are, among others, many groups of Diptera and Hymenoptera; two insect orders referred to as the "big four" (together with Lepidoptera and Coleoptera) because of their exceptional species diversity, even in comparatively species-poor regions such as the western Palaearctic (Schumann et al. 1999; Dathe et al. 2001). There is a long tradition of citizen entomologists studying certain groups of Lepidoptera and Coleoptera often by geographic region and in astonishing detail, though this is very unusual in many other insect groups such as Hymenoptera (excluding Aculeata).

A reliable assessment of insect faunas is becoming increasingly more important in the light of recent findings that report dramatic losses in insect biomass and potentially also species richness (Hallmann et al. 2017). Yet, existing species lists for non-aculeate Hymenoptera, for example, are putatively highly incomplete, error-prone or outdated (Dathe et al. 2001; Mitroiu et al. 2015). However, an assessment of Germany's biodiversity and its differences and changes over time and space cannot or should not be done without including these very species-diverse groups.

When discussing these understudied taxa and their decided importance for Germany's biodiversity, two main issues need to be considered: 1) How severe is the lack of knowledge, i.e., how reliable and complete are the published species lists? and 2) How can our knowledge on these groups be improved to meet the strategic goal of a well-known German biodiversity?

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In this study, we exemplarily screened and evaluated the currently listed records of chalcidoid wasps (Chalcidoidea), one of the very species-rich and notoriously understudied groups of parasitoid Hymenoptera. To date, there are 1963 (Schmidt 2015) or 1964 (Noyes 2018) species of Chalcidoidea checklisted for Germany (i.e., approximately 6 % of the German insect fauna). To evaluate the reliability and completeness of these records, we checked the available information in detail (taken from the well-curated Universal Chalcidoidea Database (Noyes 2018; http://www.nhm.ac.uk/our-science/data/chalcidoids/)).

First, we checked the number of referenced records from Germany for all species and the respective year of publication. Few and/or old records might indicate lower reliability of a given recorded species to actually occur in Germany. Second, we checked how many recorded species belong to groups (i.e., genera, subgenera, species groups etc.) that have been taxonomically revised in the past, especially in the last 50 years. Taxonomic revision in groups as delicate as parasitoid wasps (delicate meaning small-sized, species-rich, subtle species differences) can result in significant changes of the number of recognized species (e.g., Hansson & Shevtsova 2012; Khatib et al. 2014). Species records in unrevised taxonomic groups need to be handled with caution *per se*. Third, to get an idea of the number of species that are most likely present, but have never been formally recorded, we searched for species that occur in at least two neighboring countries of Germany. These will most likely also occur in Germany.

In a second part, we show and discuss how knowledge on Germany's biodiversity can be improved via close collaboration between citizen scientists and professionals.

Citizen scientists in entomology have excellent knowledge about regionally important habitats, they collect, sort, and mount a lot of specimens, they have profound knowledge in special groups, but also in general entomology, they may be organized in groups where they regularly exchange specimens and expertise, and perform examinations of species biology. On the other hand, professional entomologists at museums or other research institutions have state-of-the-art infrastructure (collections, molecular laboratories, etc.), taxonomic expertise in groups that are not too attractive for amateurs, and they often have the expertise to put faunistic records in a scientific context or to develop new research questions from observations, often within an international network of researchers. These areas of expertise perfectly complement each other when it comes to improving knowledge on biodiversity, in a way that serves both public and science.

The connection and cooperation between citizen scientists and professionals works well in some animal taxa, and is also inherent part of the German Barcode of Life initiative (GBOL) (Geiger et al. 2016). However, even large-scale initiatives such as GBOL cannot cover all of Germany's biodiversity. For example, most parasitoid Hymenoptera groups have been largely excluded from the first two phases of GBOL.

In this context, we add some records of chalcidoid wasps new to Germany that were found through collaboration between citizen scientists and professional hymenopterists. With our new records we demonstrate that, if collection by citizen scientists and collaboration between citizen scientists and professional entomologists is improved, new chalcidoid species can be easily found to complement our knowledge on local biodiversity. Ideally, this includes also live pictures, biological data, fine-scale distribution data and deposition of vouchers in scientific collections, i.e., species records that are far more valuable than "naked" lists, both in terms of scope and scientific validity.

Both aspects of this study in concert, however, demonstrate that collecting, collaboration and taxonomic expertise also have to be significantly expanded and improved to cover all of Germany's species diversity in a reasonable time.

MATERIAL & METHODS

Evaluating the Chalcidoidea species list for Germany

The superfamily Chalcidoidea comprises the following 23 extant families (Heraty et al. 2013; Janšta et al. 2017): Agaonidae (not occurring in Germany), Aphelinidae, Azotidae, Chalcididae, Cynipencyrtidae (not occurring in Germany), Encyrtidae, Eriaporidae (not occurring in Germany), Eucharitidae, Eulophidae, Eupelmidae, Eurytomidae, Leucospidae, Megastigmidae, Mymaridae, Ormyridae, Perilampidae, Pteromalidae, Rotoitidae (not occurring in Germany), Signiphoridae, Tanaostigmatidae, Tetracampidae, Torymidae, and Trichogrammatidae.

To evaluate the reliability and completeness of species records, we examined the information at Universal Chalcidoidea Database (UCD, Noyes 2018; http://www.nhm.ac.uk/our-science/data/chalcidoids/). In this database, all publications on Chalcidoidea and the data therein are implemented in a timely and highly complete manner by the enormous effort of John Noyes from Natural History Museum, London, a Chalcidoidea expert. John Noyes kindly provided the raw data underlying the published content at UCD, exported as a .csv file (status as of June 2017). The dataset contained all the published records of chalcidoid wasps for Germany and its neighboring countries, i.e., the Netherlands, Belgium, Luxembourg, France, Switzerland, Austria, Czech Republic, Poland, and Denmark. Each record includes the valid species name, valid genus name, author and country, and the full reference of the record, including the year of publication. Initially, all German records were sorted according to their reference year.

Fig 1. *Calosota aestivalis* (Eupelmidae: Calosotinae), a species newly recorded from Germany. **A.** female; **B.** male; **C.** female during oviposition. Live pictures are not from voucher specimen.

Next, we searched for species recorded from Germany with only one record or reference. Again, these single records were sorted according to their reference year.

Then, to locate species that have been taxonomically revised, we searched the references of all recorded species for the key terms "revision", "reclassification", "synonym", "new combination", "review", "description", "taxonomy" or any parts of the respective words. These terms should be included in the titles of at least the vast majority of taxonomic revision publications and also cover most of the respective terms in French and German. "New species" was not considered as species descriptions not necessarily include a taxonomic revision. For publications whose titles did not contain exact information about the revised taxa, the respective abstract was consulted. For all positive matches the corresponding taxa (i.e., species, genus, tribe, family) were marked as "revised" within the main excel sheet and the date of publication was noted. When a taxonomic unit was revised (e.g., genus), all subunits (e.g., species) were listed as revised. Based on the date of publication it was possible to determine how many of the revised species were taxonomically revised before and during the last 50 years.

Finally, we searched for species that occur in at least two neighboring countries of Germany that have no common borderline between them. These will most likely also occur in Germany. By specifying that the records are from two or more non-contiguous neighboring countries of Germany, we intended to exclude species that occur in geographic regions or habitats that are not necessarily present in Germany, e.g., eastern Palaearctic species or alpine species.

New Chalcidoidea records from Germany

Authors have routinely collected species of Hymenoptera in various habitats using hand nets. Live photos were taken with Canon EOS 5 Mark II, 100mm Macro (*Torymus cupreus* (Spinola, 1808)) and Nikon D7200, 60mm Macro (*Calosota aestivalis* Curtis, 1836). Specimens were killed with ethyl acetate, mounted, labelled, and identified. Specimen vouchers of the new records are deposited at Zoologisches Forschungsmuseum Alexander Koenig (ZFMK; Bonn, Germany).

Fig 2. *Torymus cupreus* (Torymidae: Toryminae), a species newly recorded from Germany.

Table 1. Records of Chalcidoidea from Germany and their distribution in terms of publication date. Records from neighboring countries not included.

Year	Proportion of records (Total = 100 %)	Number of records (Total = 5,183)
1700–1799	0.21 %	11
1800–1899	1.31 %	68
1900–1950	0.35 %	18
1951–2000	51.13 %	2,650
2001–2017	47.00 %	2,436

RESULTS

Evaluating the Chalcidoidea species list for Germany

According to the Universal Chalcidoidea Database (UCD) there are 1,964 species recorded from Germany. From this preliminary list, we excluded 29 species names or entries that were either erroneously listed twice, very recently synonymized, *nomina nuda*, or fossil taxa. There are four additional species recorded from Germany in the raw data provided by John Noyes, which are not listed in the "regional list" for Germany in the UCD website. Consequently, our final list included a total number of 1,939 chalcidoid species for Germany. For all these species a total of 5,183 records were listed. Virtually all records dated from 1951-2017 (98.13 %), and only a few (1.87 %) were from earlier publications (for details see Table 1).

Out of the 1,939 species listed from Germany, 764 (39.40 %) were documented with only one reference or record. The majority of single records (726) dated from 1951 to 2017. Regarding taxonomic revision, 551 species (28.42 %) belong to taxa that have been taxonomically revised within the last 50 years. Only 98 species (5.05 %) were revised before 1968, resulting in 649 species (33.47 %) that have ever been taxonomically revised. Regarding potential new species records for Germany, 344 species were listed in at least two neighboring countries that do not have a borderline between them. These species represent 11.3 % of the total of 3,043 species recorded from the neighboring countries. For these species an occurrence in Germany can be assumed to be probable. In summary, a total of 2,283 chalcidoid species have been recorded from Germany or can be expected to occur in Germany.

A full list of the species recorded from Germany plus those species recorded from neighboring countries which do not have a borderline between them, along with species-specific information as included in this study, is given in Appendix I.

New Chalcidoidea records from Germany

We report for the first time for Germany the occurrence of *Calosota aestivalis* Curtis, 1836 (Chalcidoidea: Eupelmidae: Calosotinae) (Fig. 1) and *Torymus cupreus* (Spinola, 1808) (Chalcidoidea: Torymidae: Toryminae) (Fig. 2).

Calosota aestivalis Curtis, 1836

Calosota aestivalis Curtis, 1836: 596.
For synonyms, distribution and associates see Noyes (2018).

Material examined. Germany: Bavaria, Landkreis Schwandorf, Schwandorf (GMS: N 49° 18' 15.347" W 12° 7' 53.025", DG: N 49.304263 W 12.131396), 29.iv.2015, south-facing woodpile next to small woodland, leg. E. Klimsa; det. E. Klimsa, G. Gibson (1 female, deposited at ZFMK, ZFMK-HYM-00012133).
Remarks. Specimens of this species were also observed on several occasions in the years 2016 and 2017 at woodpiles in Schwandorf and Kallmünz (Bavaria).

Torymus cupreus (Spinola, 1808)

Diplolepis cuprea Spinola, 1808: 212–213.
For synonyms, distribution and associates see Noyes (2018).

Material examined. Germany: Rheinland-Pfalz, Donnersbergkreis, Zell (GMS: N 49° 38' 58.87" O 8° 8'5.031", DG: 49.649686 8.134731), ivy-covered hedgerow at the village outskirts, 01.x.2015, leg. G. Reder; det. G. Reder, vid. R. Peters (1 female, deposited at ZFMK, ZFMK-HYM-00020525).

DISCUSSION

Results show that the majority of published records of chalcidoid species from Germany date from the period after the Second World War, which may indicate an in-

crement of collecting, identification and publication activities during that time. For approximately one third of the recorded species only a single record is listed. Any single event is sought to be verified or falsified to be scientifically sound. We have no information on whether these single records are correct or not; in fact, they could well be correct, and on the other hand, also multiple records can be wrong. Ideally, we would have checked if records are vouchered in a scientific collection and could be verified accordingly. Our expectation was that the number of voucher-referenced records was very low, rendering most records not necessarily wrong but scientifically flawed. A thorough check for vouchers was not done, due to time constraints. However, when checking this for 20 randomly chosen species, we found almost no detailed collecting information or references to deposited vouchers. Almost half of the records (47 %, see Table 1) date from rather recently, which indicates that the study of Germany's chalcidoid fauna has accelerated, and that the quality of the records should increase with more and more recent records added.

The fact that only 33.5 % of the recorded species from Germany have been taxonomically revised (based on our search for key terms in the publication titles) might severely flaw the reliability of the known records. Taxonomic revisions in chalcidoid wasps usually result in significant additions or subtractions of recognized valid species. Recent examples from European chalcidoid taxa include the *Eupelmus urozonus* group (Eupelmidae) (now 21 valid species, but only nine species before revision; Khatib *et al.* 2014), *Dibrachys cavus* group (Pteromalidae) (now three valid species, but five species before Peters & Baur (2011) and 12 species before Gahan (1938)), the genus *Omphale* (Eulophidae) (now 37 valid species, but 31 species before Hansson & Shevtsova 2012), and the genus *Copidosoma* (Encyrtidae) (now 58 valid species, but 84 species before Guerrieri & Noyes 2005). Furthermore, *Pteromalus* Swederus, 1795, one of the most species-rich genera of Chalcidoidea with 271 species listed for Germany, has never been revised, but currently ongoing studies suggest a significant impact of revision on the number of valid species for this genus (unpublished). We need to stress that taxonomic work, in terms of revisionary work for taxonomic clarity, is crucial for any accurate species list and the basis for any further application of these lists in ecology, conservation, or biogeography. The low percentage of taxonomically revised taxa points towards two major problems in our knowledge of German Chalcidoidea: 1) the lists could well be grossly wrong in terms of true species, and 2) the number of scientists working on the taxonomy of chalcidoid (or any parasitoid) wasps is too low. There are very few specialists working on these groups. Actually, chalcidoid wasps range among the most studied and surveyed parasitoid wasp taxa in Germany, with a handful of specialists working on them; so, the situation is worse or much worse in other diverse Hymenoptera groups. The result that only 33.5 % of the taxa have been taxonomically revised means that we have no clue about the taxonomic status of two-thirds of the chalcidoid wasp species in our own local fauna. Any study using the current list will be substantially flawed.

The number of species from neighboring countries is lower than we originally anticipated, but still, another 344 chalcidoid species are likely to be present in Germany (an increment of almost 18 % from the total). Most of these species are recorded from the Czech Republic, France and the Netherlands. This east-west axis includes the major part of the neighboring species that probably also occur in Germany. The examples of France and the Czech Republic show the positive impact on the species inventory by the work of taxonomic experts such as J.-Y. Rasplus and G. Delvare in France, and Z. Bouček in the Czech Republic.

If one looks into the chalcidoid fauna in more detail, new records for Germany can be found rather easily. We complemented our manuscript with two new species records from Germany for species already recorded from neighboring countries, collected by citizen scientists Gerd Reder and Ernst Klimsa. Both are active hymenopterists that frequently collect and photograph hymenopterans mainly in their local vicinity. Both authors approached the senior author (RSP) of this study with some photos and some questions on the identity of the depicted species and sent the specimens to the ZFMK for further examination. In collaboration with Gary Gibson, a well-renowned expert on Chalcidoidea at the Canadian National Collection (CNC, Ottawa, Canada), the specimens were identified. Both new records included exact collecting data as well as live pictures. This additional information is very rare and highly welcome. For many parasitoid species only very sparse additional information is recorded and often none at all. Of course, information on host association is most valuable. This information is also missing or fragmentary for many species. As an example, we checked the records of 200 randomly chosen species from Germany and found no or only one reference on host association for 17 % of the species. The two new German records presented here illustrate how rapid, easy and helpful joint efforts of citizen and professional entomologists can be, even in groups such as parasitoid Hymenoptera. Of course, many parasitoid groups are even more problematic than Chalcidoidea and harbor problems such as the need of taxonomic work, minute size and no available experts that will make improvement of knowledge of the local fauna exceedingly more difficult.

To provide reliable and complete species lists is only part of solving the problem of parasitoid wasps being widely neglected in science, politics and public. The other part, although tightly linked to the production of reliable species lists, is more taxonomic work and revi-

sions, the increased use of modern molecular and morphological tools in taxonomy and species identification, the publication of easy-to-use identification keys, and the education and funding of taxonomic experts. We call for future intensive collections of Germany's chalcidoid (and parasitoid) fauna, and for intensive collaboration of citizen and professional entomologists as well as for large-scale taxonomy and monitoring projects to overcome the unbearable situation that we have no or only meagre knowledge on a significant portion of Germany's biodiversity. The latest results showing that insect populations decrease at a rapid speed (Hallmann et al. 2017) urge for fast and sweeping assessments of biodiversity in order to drastically improve our understanding of local fauna and to guard against potential loss of Germany's biological heritage.

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REFERENCES

Al Khatib F, Fusu L, Cruaud A, Gibson G, Borowiec N, Rasplus J-Y, Ris N, Delvare G (2014) An integrative approach to species discrimination in the *Eupelmus urozonus* complex (Hymenoptera, Eupelmidae), with the description of 11 new species from the Western Palaearctic. Systematic Entomology 39: 806–862

Dathe HH, Taeger A, Blank SM (eds) (2001) Verzeichnis der Hautflügler Deutschlands (Entomofauna Germanica 4). Entomologische Nachrichten und Berichte (Dresden), Beiheft 7: 1–175

Gahan AB (1938) Notes on some genera and species of Chalcidoidea (Hymenoptera). Proceedings of the Entomological Society of Washington 40: 209–227

Geiger MF, Astrin JJ, Borsch T, Burkhardt U, Grobe P, Hand R, Hausmann A, Hohberg K, Krogmann L, Lutz M, Monje C, Misof B, Moriniere J, Müller K, Pietsch S, Quandt D, Rulik B, Scholler M, Traunspurger W, Haszprunar G, Wägele W (2016) How to tackle the molecular species inventory for an industrialized nation-lessons from the first phase of the German Barcode of Life initiative GBOL (2012-2015). Genome 59: 661–670

Guerrieri E, Noyes J (2005) Revision of the European species of *Copidosoma* Ratzeburg (Hymenoptera: Encyrtidae), parasitoids of caterpillars (Lepidoptera). Systematic Entomology 30: 97–174

Hallmann CA, Sorg M, Jongejans E, Siepel H, Hofland N, Schwan H, Stenmans W, Müller A, Sumser H, Hörren T, Goulson D, de Kroon H (2017) More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLoS ONE 12(10): e0185809

Hansson C, Shevtsova E (2012) Revision of the European species of *Omphale* Haliday (Hymenoptera, Chalcidoidea, Eulophidae). ZooKeys 232: 1–157

Heraty JM, Burks RA, Cruaud A, Gibson GAP, Liljeblad J, Munro J, Rasplus JY, Delvare G, Janšta P, Gumovsky A, Huber JT, Woolley JB, Krogmann L, Heydon SL, Polaszek A, Schmidt S, Darling DC, Gates MW, Mottern J, Murray E, Molin AD, Triapitsyn S, Baur H, Pinto JD, van Noort S, George J, Yoder MJ (2013) A phylogenetic analysis of the megadiverse Chalcidoidea (Hymenoptera). Cladistics 29: 466–542

Janšta P, Cruaud A, Delvare G, Genson G, Heraty J, Křížková B, Rasplus JY (2017) Torymidae (Hymenoptera, Chalcidoidea) revised: molecular phylogeny, circumscription and reclassification of the family with discussion of its biogeography and evolution of life-history traits. Cladistics: 1–25

Mitroiu M, Noyes J, Cetkovic A, Nonveiller G, Radchenko A, Polaszek A, Ronquist F, Forshage M, Pagliano G, Gusenleitner J, Bartalucci M, Olmi M, Fusu L, Madl M, Johnson N, Jansta P, Wahis R, Soon V, Rosa P, Osten T, Barbier Y, de Jong Y (2015). Fauna Europaea: Hymenoptera – Apocrita (excl. Ichneumonoidea). Biodiversity Data Journal 3: e4186

Noyes JS (2018) Universal Chalcidoidea Database. WorldWideWeb electronic publication. http://www.nhm.ac.uk/entomology/chalcidoids/index.html

Peters RS, Baur H (2011) A revision of the *Dibrachys cavus* species complex (Hymenoptera: Chalcidoidea: Pteromalidae). Zootaxa 2937: 1–30

Schmidt S (2015) Checklist of German Chalcidoidea (Hymenoptera). WorldWideWeb electronic publication. http://www.zsm.mwn.de/docs_zsm/htdocs/hym/chal/e/overview.html

Schumann H, Bährmann R, Stark A. (eds) (1999) Checkliste der Dipteren Deutschlands. Studia dipterologica Supplement 2: 1–354

Völkl W, Blick T, Kornacker PM, Martens H (2004) Quantitativer Überblick über die rezente Fauna von Deutschland. Natur und Landschaft 79: 293–295

APPENDIX I

(*electronic supplement, available at www.bonnzoologicalbulletin.de*)

List of Chalcidoidea species recorded from Germany, based on the Universal Chalcidoidea Database, with some corrections of the original data and with species-specific data on the record and the species' taxonomy. In red species recorded from Germany; in green species recorded from neighboring countries of Germany that do not have a border between them.

APPENDIX 1

Supplementary material. List of Chalcidoidea species recorded from Germany, based on the Universal Chalcidoidea Database, with some corrections of the original data and with species-specific data on the record and the species' taxonomy. In red species recorded from Germany; in green species recorded from neighboring countries of Germany that do not have a border between them.

family	species	author	distribution	revision (year)	single record (year)
Aphelinidae	*Aphelinus abdominalis*	(Dalman)	Germany	2014	
Aphelinidae	*Aphelinus annulipes*	(Walker)	Germany	2014	
Aphelinidae	*Aphelinus argiope*	Walker	Germany	2014	2001
Aphelinidae	*Aphelinus asychis*	Walker	Germany	2017	
Aphelinidae	*Aphelinus chaonia*	Walker	Germany	2014	
Aphelinidae	*Aphelinus circumscriptus*	(Ratzeburg)	Germany	2014	2001
Aphelinidae	*Aphelinus flavus*	(Nees)	Germany	2014	2001
Aphelinidae	*Aphelinus fusciscapus*	(Förster)	Germany	2014	2001
Aphelinidae	*Aphelinus longipennis*	(Förster)	Germany	2014	2001
Aphelinidae	*Aphelinus mali*	(Haldeman)	Germany	2014	
Aphelinidae	*Aphelinus notatus*	(Ratzeburg)	Germany	2014	2001
Aphelinidae	*Aphelinus semiflavus*	Howard	Germany	2014	
Aphelinidae	*Aphelinus varipes*	(Förster)	Germany	2014	
Aphelinidae	*Aphytis chilensis*	Howard	Germany		
Aphelinidae	*Aphytis chrysomphali*	(Mercet)	Germany		2001
Aphelinidae	*Aphytis luteus*	(Ratzeburg)	Germany		
Aphelinidae	*Aphytis mytilaspidis*	(Le Baron)	Germany		
Aphelinidae	*Aphytis proclia*	(Walker)	Germany		
Aphelinidae	*Centrodora acridiphagus*	(Otten)	Germany		
Aphelinidae	*Centrodora amoena*	Förster	Germany		2001
Aphelinidae	*Centrodora speciosissima*	(Girault)	Germany		
Aphelinidae	*Centrodora tibialis*	(Nees)	Germany		2001
Aphelinidae	*Coccobius annulicornis*	Ratzeburg	Germany	2010	
Aphelinidae	*Coccophagus gossypariae*	Gahan	Germany		2003
Aphelinidae	*Coccophagus insidiator*	(Dalman)	Germany		
Aphelinidae	*Coccophagus lycimnia*	(Walker)	Germany		
Aphelinidae	*Coccophagus palaeolecanii*	Yasnosh	Germany		
Aphelinidae	*Coccophagus pulchellus*	Westwood	Germany		
Aphelinidae	*Coccophagus scutatus*	Howard	Germany		1997
Aphelinidae	*Coccophagus scutellaris*	(Dalman)	Germany		
Aphelinidae	*Coccophagus semicircularis*	(Förster)	Germany		
Aphelinidae	*Diaspiniphagus moeris*	(Walker)	Germany		
Aphelinidae	*Encarsia aleurochitonis*	(Mercet)	Germany		2001
Aphelinidae	*Encarsia aurantii*	(Howard)	Germany		
Aphelinidae	*Encarsia berlesei*	(Howard)	Germany		

family	species	author	distribution	revision (year)	single record (year)
Aphelinidae	*Encarsia citrina*	(Craw)	Germany		
Aphelinidae	*Encarsia fasciata*	(Malenotti)	Germany		
Aphelinidae	*Encarsia formosa*	Gahan	Germany		
Aphelinidae	*Encarsia inaron*	(Walker)	Germany		
Aphelinidae	*Encarsia intermedia*	(Ferrière)	Germany		
Aphelinidae	*Encarsia leucaspidis*	(Mercet)	Germany		
Aphelinidae	*Encarsia margaritiventris*	(Mercet)	Germany		2001
Aphelinidae	*Encarsia perniciosi*	(Tower)	Germany		
Aphelinidae	*Encarsia tricolor*	Förster	Germany		
Aphelinidae	*Eretmocerus californicus*	Howard	Germany		1994
Aphelinidae	*Eretmocerus mundus*	Mercet	Germany		
Aphelinidae	*Marietta picta*	(André)	Germany		
Aphelinidae	*Pteroptrix bicolor*	(Howard)	Germany		
Aphelinidae	*Pteroptrix longiclava*	(Girault)	Germany		
Azotidae	*Ablerus atomon*	(Walker)	Germany		2001
Azotidae	*Ablerus pinifoliae*	(Mercet)	Germany		
Chalcididae	*Belaspidia obscura*	Masi	Germany	1999	
Chalcididae	*Brachymeria femorata*	(Panzer)	Germany	1952	
Chalcididae	*Brachymeria minuta*	(Linnaeus)	Germany	1952	
Chalcididae	*Brachymeria moerens*	(Ruschka)	Germany	1952	2001
Chalcididae	*Brachymeria obtusata*	(Förster)	Germany	1952	
Chalcididae	*Brachymeria parvula*	(Walker)	Germany	1952	
Chalcididae	*Brachymeria podagrica*	(Fabricius)	Germany	1952	2001
Chalcididae	*Brachymeria rugulosa*	(Förster)	Germany	1952	2001
Chalcididae	*Brachymeria secundaria*	(Ruschka)	Germany	1952	2001
Chalcididae	*Brachymeria tibialis*	(Walker)	Germany	1952	
Chalcididae	*Brachymeria vitripennis*	(Förster)	Germany	1952	
Chalcididae	*Chalcis biguttata*	Spinola	Germany	1952	
Chalcididae	*Chalcis femorata*	Nees	Germany	1952	2001
Chalcididae	*Chalcis myrifex*	(Sulzer)	Germany	1952	
Chalcididae	*Chalcis ramicornis*	Gravenhorst	Germany	1952	2001
Chalcididae	*Chalcis sispes*	(Linnaeus)	Germany	1952	
Chalcididae	*Conura xanthostigma*	(Dalman)	Germany	1952	2001
Chalcididae	*Euchalcis magna*	Bouček	Germany	2017	2001
Chalcididae	*Haltichella rufipes*	(Olivier)	Germany	1952	
Chalcididae	*Hybothorax graffii*	Ratzeburg	Germany	1952	
Chalcididae	*Neohybothorax hetera*	(Walker)	Germany	1952	
Chalcididae	*Psilochalcis benoisti*	(Steffan)	Germany	1952	2001
Chalcididae	*Psilochalcis subarmata*	(Förster)	Germany	1952	2001
Encyrtidae	*Acerophagus austriacus*	(Mercet)	Germany		
Encyrtidae	*Acerophagus malinus*	(Gahan)	Germany		
Encyrtidae	*Adelencyrtus aulacaspidis*	(Brèthes)	Germany		

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family	species	author	distribution	revision (year)	single record (year)
Encyrtidae	*Adelencyrtus intersectus*	(Fonscolombe)	Germany		
Encyrtidae	*Ageniaspis atricollis*	(Dalman)	Germany		
Encyrtidae	*Ageniaspis fuscicollis*	(Dalman)	Germany		
Encyrtidae	*Ageniaspis testaceipes*	(Ratzeburg)	Germany		
Encyrtidae	*Aglyptus rufus*	(Dalman)	Germany		
Encyrtidae	*Anagyrietta pantherina*	Ferrière	Germany		
Encyrtidae	*Anagyrus belibus*	(Walker)	Germany		2003
Encyrtidae	*Anagyrus matritensis*	(Mercet)	Germany		
Encyrtidae	*Anagyrus schmuttereri*	Ferrière	Germany		
Encyrtidae	*Anagyrus schoenherri*	(Westwood)	Germany		
Encyrtidae	*Anagyrus securicornis*	Domenichini	Germany		
Encyrtidae	*Anomalicornia tenuicornis*	Mercet	Germany		
Encyrtidae	*Anthemus pini*	Ferrière	Germany		
Encyrtidae	*Anusia nasicornis*	Förster	Germany		
Encyrtidae	*Aphycoides clavellatus*	(Dalman)	Germany		
Encyrtidae	*Aphycoides tenuis*	(Ratzeburg)	Germany		
Encyrtidae	*Aphycus apicalis*	(Dalman)	Germany	1916	
Encyrtidae	*Aphycus hederaceus*	(Westwood)	Germany	1916	
Encyrtidae	*Aphycus sumavicus*	Hoffer	Germany	1916	2003
Encyrtidae	*Baeocharis pascuorum*	Mayr	Germany		
Encyrtidae	*Blastothrix brittanica*	Girault	Germany		
Encyrtidae	*Blastothrix erythrostetha*	(Walker)	Germany		
Encyrtidae	*Blastothrix hungarica*	Erdös	Germany		
Encyrtidae	*Blastothrix ilicicola*	Mercet	Germany		
Encyrtidae	*Blastothrix longipennis*	Howard	Germany		
Encyrtidae	*Blastothrix sericea*	(Dalman)	Germany		
Encyrtidae	*Blastothrix truncatipennis*	(Ferrière)	Germany		
Encyrtidae	*Bothriothorax altensteinii*	Ratzeburg	Germany		
Encyrtidae	*Bothriothorax clavicornis*	(Dalman)	Germany		
Encyrtidae	*Bothriothorax intermedius*	Claridge	Germany		1999
Encyrtidae	*Bothriothorax paradoxus*	(Dalman)	Germany		
Encyrtidae	*Bothriothorax wichmani*	Ferrière	Germany		
Encyrtidae	*Boučekiella depressa*	Hoffer	Germany		2003
Encyrtidae	*Cerapterocerus celadus*	(Walker)	Germany	1964	
Encyrtidae	*Cerapterocerus mirabilis*	Westwood	Germany	1964	
Encyrtidae	*Cerchysius subplanus*	(Dalman)	Germany		
Encyrtidae	*Cercobelus jugaeus*	(Walker)	Germany		1999
Encyrtidae	*Charitopus fulviventris*	Förster	Germany		2001
Encyrtidae	*Cheiloneurus claviger*	Thomson	Germany		
Encyrtidae	*Cheiloneurus elegans*	(Dalman)	Germany		
Encyrtidae	*Cheiloneurus glaphyra*	(Walker)	Germany		2001

family	species	author	distribution	revision (year)	single record (year)
Encyrtidae	*Cheiloneurus paralia*	(Walker)	Germany		
Encyrtidae	*Choreia inepta*	(Dalman)	Germany		
Encyrtidae	*Coccidencyrtus phenacocci*	Ferrière	Germany		
Encyrtidae	*Coelopencyrtus arenarius*	(Erdös)	Germany		
Encyrtidae	*Copidosoma agrotis*	(Fonscolombe)	Germany	2013	
Encyrtidae	*Copidosoma aithyia*	(Walker)	Germany	2013	
Encyrtidae	*Copidosoma albipes*	(Westwood)	Germany	2013	
Encyrtidae	*Copidosoma aretas*	(Walker)	Germany	2013	
Encyrtidae	*Copidosoma boucheanum*	Ratzeburg	Germany	2013	
Encyrtidae	*Copidosoma cervius*	(Walker)	Germany	2013	2005
Encyrtidae	*Copidosoma chalconotum*	(Dalman)	Germany	2013	
Encyrtidae	*Copidosoma cuproviride*	Springate & Noyes	Germany	2013	2005
Encyrtidae	*Copidosoma dius*	(Walker)	Germany	2013	2001
Encyrtidae	*Copidosoma filicorne*	(Dalman)	Germany	2013	
Encyrtidae	*Copidosoma flagellare*	(Dalman)	Germany	2013	
Encyrtidae	*Copidosoma floridanum*	(Ashmead)	Germany	2013	
Encyrtidae	*Copidosoma fuscisquama*	(Thomson)	Germany	2013	2005
Encyrtidae	*Copidosoma genale*	(Thomson)	Germany	2013	
Encyrtidae	*Copidosoma iracundum*	Erdös	Germany	2013	2005
Encyrtidae	*Copidosoma peticus*	(Walker)	Germany	2013	
Encyrtidae	*Copidosoma serricorne*	(Dalman)	Germany	2013	
Encyrtidae	*Copidosoma sosares*	(Walker)	Germany	2013	
Encyrtidae	*Copidosoma terebrator*	Mayr	Germany	2013	
Encyrtidae	*Copidosoma thebe*	(Walker)	Germany	2013	
Encyrtidae	*Copidosoma truncatellum*	(Dalman)	Germany	2013	
Encyrtidae	*Copidosoma varicorne*	(Nees)	Germany	2013	
Encyrtidae	*Dinocarsis hemiptera*	(Dalman)	Germany	1966	2001
Encyrtidae	*Dinocarsis hofferi*	Graham	Germany		
Encyrtidae	*Discodes aeneus*	(Dalman)	Germany		
Encyrtidae	*Discodes coccophagus*	(Ratzeburg)	Germany		
Encyrtidae	*Discodes differens*	Yasnosh	Germany		
Encyrtidae	*Discodes encopiformis*	(Walker)	Germany		
Encyrtidae	*Echthroplexis puncticollis*	(Thomson)	Germany		
Encyrtidae	*Ectroma fulvescens*	Westwood	Germany	2007	
Encyrtidae	*Ectroma reinhardi*	(Mayr)	Germany	2007	
Encyrtidae	*Encyrtus albitarsis*	Zetterstedt	Germany		
Encyrtidae	*Encyrtus aurantii*	(Geoffroy)	Germany		1997
Encyrtidae	*Encyrtus flavipes*	Nees	Germany		2001
Encyrtidae	*Encyrtus foersteri*	Mayr	Germany		2001
Encyrtidae	*Encyrtus infelix*	(Embleton)	Germany		1989
Encyrtidae	*Encyrtus infidus*	(Rossi)	Germany		

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family	species	author	distribution	revision (year)	single record (year)
Encyrtidae	*Encyrtus mucronatus*	Ratzeburg	Germany		2001
Encyrtidae	*Encyrtus swederi*	Dalman	Germany		
Encyrtidae	*Ericydnus apterogenes*	Mayr	Germany	1991	
Encyrtidae	*Ericydnus baleus*	(Walker)	Germany	1991	2003
Encyrtidae	*Ericydnus longicornis*	(Dalman)	Germany	1991	
Encyrtidae	*Ericydnus robustior*	Mercet	Germany	1991	
Encyrtidae	*Ericydnus sipylus*	(Walker)	Germany	1991	2001
Encyrtidae	*Ericydnus strigosus*	(Nees)	Germany	1991	2001
Encyrtidae	*Ericydnus theron*	Trjapitzin	Germany	1991	
Encyrtidae	*Ericydnus ventralis*	(Dalman)	Germany	1991	
Encyrtidae	*Eucoccidophagus semiluniger*	(Hoffer)	Germany		
Encyrtidae	*Eugahania fumipennis*	(Ratzeburg)	Germany		
Encyrtidae	*Eupoecilopoda perpunctata*	(Masi)	Germany		
Encyrtidae	*Eusemion cornigerum*	(Walker)	Germany		
Encyrtidae	*Eusemion longipennis*	(Ashmead)	Germany		
Encyrtidae	*Habrolepis dalmanni*	(Westwood)	Germany	1993	
Encyrtidae	*Helegonatopus dimorphus*	(Hoffer)	Germany		
Encyrtidae	*Heterococcidoxenus schlechtendali*	(Mayr)	Germany		
Encyrtidae	*Homalotylus ephippium*	(Ruschka)	Germany		
Encyrtidae	*Homalotylus eytelweinii*	(Ratzeburg)	Germany		
Encyrtidae	*Homalotylus flaminius*	(Dalman)	Germany		
Encyrtidae	*Homalotylus hemipterinus*	(De Stefani)	Germany		2010
Encyrtidae	*Homalotylus platynaspidis*	Hoffer	Germany		2006
Encyrtidae	*Isodromus vinulus*	(Dalman)	Germany	1969	
Encyrtidae	*Ixodiphagus hookeri*	(Howard)	Germany		
Encyrtidae	*Lamennaisia ambigua*	(Nees)	Germany		
Encyrtidae	*Lamennaisia nobilis*	(Nees)	Germany		
Encyrtidae	*Leptomastidea bifasciata*	(Mayr)	Germany		
Encyrtidae	*Leptomastix epona*	(Walker)	Germany		
Encyrtidae	*Leptomastix histrio*	(Förster)	Germany		2001
Encyrtidae	*Leptomastix mayri*	Özdikmen	Germany		1972
Encyrtidae	*Mahencyrtus comara*	(Walker)	Germany		
Encyrtidae	*Mayrencyrtus imandes*	(Walker)	Germany		
Encyrtidae	*Mayridia merceti*	Trjapitzin	Germany		2001
Encyrtidae	*Mayridia myrlea*	(Walker)	Germany		
Encyrtidae	*Mayridia procera*	(Mercet)	Germany		
Encyrtidae	*Metaphycus asterolecanii*	(Mercet)	Germany	2000	
Encyrtidae	*Metaphycus chermis*	(Fonscolombe)	Germany	2000	
Encyrtidae	*Metaphycus delos*	Guerrieri & Noyes	Germany	2000	2001
Encyrtidae	*Metaphycus insidiosus*	(Mercet)	Germany	2000	
Encyrtidae	*Metaphycus maculipennis*	(Timberlake)	Germany	2000	2003

family	species	author	distribution	revision (year)	single record (year)
Encyrtidae	*Metaphycus melanostomatus*	(Timberlake)	Germany	2000	
Encyrtidae	*Metaphycus nitens*	(Kurdjumov)	Germany	2000	
Encyrtidae	*Metaphycus punctipes*	(Dalman)	Germany	2000	
Encyrtidae	*Metaphycus silvestrii*	Sugonjaev	Germany	2000	
Encyrtidae	*Metaphycus stagnarum*	Hoffer	Germany	2000	2003
Encyrtidae	*Metaphycus unicolor*	Hoffer	Germany	2000	2003
Encyrtidae	*Metaphycus zebratus*	(Mercet)	Germany	2000	
Encyrtidae	*Microterys aeneiventris*	(Walker)	Germany	2011	
Encyrtidae	*Microterys apicipennis*	Bakkendorf	Germany	2011	2001
Encyrtidae	*Microterys chalcostomus*	(Dalman)	Germany	2011	
Encyrtidae	*Microterys cyanocephalus*	(Dalman)	Germany	2011	
Encyrtidae	*Microterys duplicatus*	(Nees)	Germany	2011	
Encyrtidae	*Microterys ferrugineus*	(Nees)	Germany	2011	
Encyrtidae	*Microterys fuscipennis*	(Dalman)	Germany	2011	
Encyrtidae	*Microterys hortulanus*	Erdös	Germany	2011	
Encyrtidae	*Microterys lunatus*	(Dalman)	Germany	2011	
Encyrtidae	*Microterys masii*	Silvestri	Germany	2011	
Encyrtidae	*Microterys nietneri*	(Motschulsky)	Germany	2011	
Encyrtidae	*Microterys sceptriger*	(Förster)	Germany	2011	
Encyrtidae	*Microterys sylvius*	(Dalman)	Germany	2011	
Encyrtidae	*Microterys tessellatus*	(Dalman)	Germany	2011	
Encyrtidae	*Microterys trjapitzini*	Yasnosh	Germany	2011	
Encyrtidae	*Microterys zarina*	(Walker)	Germany	2011	
Encyrtidae	*Mira mucora*	Schellenberg	Germany	1977	
Encyrtidae	*Oobius zahaikevitshi*	Trjapitzin	Germany		
Encyrtidae	*Ooencyrtus fulvipes*	Hoffer	Germany		
Encyrtidae	*Ooencyrtus gravis*	(Nees)	Germany		
Encyrtidae	*Ooencyrtus kuvanae*	(Howard)	Germany		
Encyrtidae	*Ooencyrtus tardus*	(Ratzeburg)	Germany		
Encyrtidae	*Ooencyrtus telenomicida*	(Vassiliev)	Germany		
Encyrtidae	*Ooencyrtus vinulae*	(Masi)	Germany		
Encyrtidae	*Parablastothrix metatibialis*	Erdös	Germany		
Encyrtidae	*Parablastothrix montana*	Erdös	Germany		
Encyrtidae	*Parablastothrix plugarui*	Trjapitzin	Germany		
Encyrtidae	*Parablatticida brevicornis*	(Dalman)	Germany		
Encyrtidae	*Platencyrtus parkeri*	Ferrière	Germany		2003
Encyrtidae	*Prionomastix morio*	(Dalman)	Germany		
Encyrtidae	*Prionomitus mitratus*	(Dalman)	Germany	1981	
Encyrtidae	*Prionomitus tiliaris*	(Dalman)	Germany		
Encyrtidae	*Pseudencyrtus eupelmoides*	(Ratzeburg)	Germany		
Encyrtidae	*Pseudencyrtus idmon*	(Walker)	Germany		2007

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family	species	author	distribution	revision (year)	single record (year)
Encyrtidae	*Pseudencyrtus misellus*	(Dalman)	Germany		
Encyrtidae	*Pseudencyrtus salicisstrobili*	(Linnaeus)	Germany		
Encyrtidae	*Pseudleptomastix brevipennis*	(Ferrière)	Germany		
Encyrtidae	*Pseudorhopus testaceus*	(Ratzeburg)	Germany		
Encyrtidae	*Psilophrys tenuicornis*	Graham	Germany		
Encyrtidae	*Rhopus brachypterus*	(Mercet)	Germany		
Encyrtidae	*Rhopus parvulus*	(Mercet)	Germany		
Encyrtidae	*Rhopus piso*	(Walker)	Germany		2001
Encyrtidae	*Rhopus semiapterus*	(Mercet)	Germany		
Encyrtidae	*Rhopus sulphureus*	(Westwood)	Germany		2001
Encyrtidae	*Sectiliclava cleone*	(Walker)	Germany		2006
Encyrtidae	*Subprionomitus festucae*	(Mayr)	Germany		
Encyrtidae	*Syrphophagus aeruginosus*	(Dalman)	Germany	1970	
Encyrtidae	*Syrphophagus aphidivorus*	(Mayr)	Germany	1970	
Encyrtidae	*Syrphophagus herbidus*	(Dalman)	Germany	1970	
Encyrtidae	*Syrphophagus hyalipennis*	(Mayr)	Germany	1970	
Encyrtidae	*Syrphophagus mamitus*	(Walker)	Germany	1970	
Encyrtidae	*Syrphophagus pertiades*	(Walker)	Germany	1970	
Encyrtidae	*Syrphophagus taeniatus*	(Förster)	Germany	1970	
Encyrtidae	*Tachinaephagus zealandicus*	Ashmead	Germany		2014
Encyrtidae	*Tetracnemoidea piceae*	(Erdös)	Germany		
Encyrtidae	*Tetracnemoidea spilococci*	Ferrière	Germany		
Encyrtidae	*Tetracnemus diversicornis*	Westwood	Germany	2012	2001
Encyrtidae	*Tetracnemus heydeni*	(Mayr)	Germany	2012	
Encyrtidae	*Thomsonisca amathus*	(Walker)	Germany		
Encyrtidae	*Trechnites fuscitarsis*	(Thomson)	Germany	2009	2009
Encyrtidae	*Trechnites insidiosus*	(Crawford)	Germany	2009	
Encyrtidae	*Trichomasthus albimanus*	Thomson	Germany		
Encyrtidae	*Trichomasthus cyaneus*	(Dalman)	Germany		
Encyrtidae	*Trichomasthus cyanifrons*	(Dalman)	Germany		
Encyrtidae	*Trichomasthus dignus*	Khlopunov	Germany		2003
Encyrtidae	*Trichomasthus frontalis*	Alam	Germany		
Encyrtidae	*Trichomasthus marsus*	(Walker)	Germany		
Encyrtidae	*Tyndarichus melanacis*	(Dalman)	Germany		
Encyrtidae	*Tyndarichus navae*	Howard	Germany		1999
Encyrtidae	*Tyndarichus scaurus*	(Walker)	Germany		2001
Encyrtidae	*Zaomma eriococci*	(Ferrière)	Germany		
Encyrtidae	*Zaomma hirsuta*	(Ratzeburg)	Germany		
Encyrtidae	*Zaomma lambinus*	(Walker)	Germany		
Eucharitidae	*Eucharis adscendens*	(Fabricius)	Germany	2002	
Eucharitidae	*Stilbula cyniformis*	(Rossi)	Germany	2002	

family	species	author	distribution	revision (year)	single record (year)
Eulophidae	*Aceratoneuromyia granularis*	Domenichini	Germany		
Eulophidae	*Achrysocharoides acerianus*	(Askew)	Germany		
Eulophidae	*Achrysocharoides atys*	(Walker)	Germany		
Eulophidae	*Achrysocharoides carpini*	Bryan	Germany		
Eulophidae	*Achrysocharoides cilla*	(Walker)	Germany		
Eulophidae	*Achrysocharoides cruentus*	Hansson	Germany		
Eulophidae	*Achrysocharoides insignitellae*	(Erdös)	Germany		
Eulophidae	*Achrysocharoides latreillii*	(Curtis)	Germany		
Eulophidae	*Achrysocharoides nigricoxae*	(Delucchi)	Germany		
Eulophidae	*Achrysocharoides niveipes*	(Thomson)	Germany		
Eulophidae	*Achrysocharoides robiniae*	Hansson & Shevtsova	Germany		
Eulophidae	*Achrysocharoides splendens*	(Delucchi)	Germany		
Eulophidae	*Achrysocharoides suprafolius*	(Askew)	Germany		
Eulophidae	*Achrysocharoides usticrus*	(Erdös)	Germany		
Eulophidae	*Achrysocharoides zwoelferi*	(Delucchi)	Germany		
Eulophidae	*Allocerastichus doderi*	Masi	Germany		
Eulophidae	*Anaprostocetus acuminatus*	(Ratzeburg)	Germany		
Eulophidae	*Aprostocetus aethiops*	(Zetterstedt)	Germany		
Eulophidae	*Aprostocetus annulatus*	(Förster)	Germany		
Eulophidae	*Aprostocetus apama*	(Walker)	Germany		2001
Eulophidae	*Aprostocetus aquaticus*	(Erdös)	Germany		
Eulophidae	*Aprostocetus arenarius*	(Erdös)	Germany		
Eulophidae	*Aprostocetus aristaeus*	(Walker)	Germany		
Eulophidae	*Aprostocetus artemisicola*	Graham	Germany		2001
Eulophidae	*Aprostocetus boreus*	(Delucchi)	Germany		
Eulophidae	*Aprostocetus brachycerus*	(Thomson)	Germany		
Eulophidae	*Aprostocetus bruzzonis*	(Masi)	Germany		
Eulophidae	*Aprostocetus calamarius*	Graham	Germany		
Eulophidae	*Aprostocetus caudatus*	Westwood	Germany		
Eulophidae	*Aprostocetus cecidomyiarum*	(Bouché)	Germany		
Eulophidae	*Aprostocetus ciliatus*	(Nees)	Germany		
Eulophidae	*Aprostocetus citrinus*	(Förster)	Germany		
Eulophidae	*Aprostocetus citripes*	(Thomson)	Germany		
Eulophidae	*Aprostocetus clavicornis*	(Zetterstedt)	Germany		
Eulophidae	*Aprostocetus collega*	(Ratzeburg)	Germany		
Eulophidae	*Aprostocetus crino*	(Walker)	Germany		2001
Eulophidae	*Aprostocetus diversus*	(Förster)	Germany		
Eulophidae	*Aprostocetus elongatus*	(Förster)	Germany		
Eulophidae	*Aprostocetus emesa*	(Walker)	Germany		
Eulophidae	*Aprostocetus epicharmus*	(Walker)	Germany		
Eulophidae	*Aprostocetus eriophyes*	(Taylor)	Germany		

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family	species	author	distribution	revision (year)	single record (year)
Eulophidae	*Aprostocetus escherichi*	(Szelényi)	Germany		
Eulophidae	*Aprostocetus eupatorii*	Kurdjumov	Germany		
Eulophidae	*Aprostocetus flavovarius*	(Nees)	Germany		2001
Eulophidae	*Aprostocetus fulvipes*	(Förster)	Germany		
Eulophidae	*Aprostocetus gaus*	(Walker)	Germany		
Eulophidae	*Aprostocetus gratus*	(Giraud)	Germany		
Eulophidae	*Aprostocetus hagenowii*	(Ratzeburg)	Germany		
Eulophidae	*Aprostocetus leptoneuros*	(Ratzeburg)	Germany		
Eulophidae	*Aprostocetus leucone*	(Walker)	Germany		
Eulophidae	*Aprostocetus longicauda*	(Thomson)	Germany		2001
Eulophidae	*Aprostocetus longiscapus*	(Thomson)	Germany		
Eulophidae	*Aprostocetus luteus*	(Ratzeburg)	Germany		
Eulophidae	*Aprostocetus lycidas*	(Walker)	Germany		
Eulophidae	*Aprostocetus lysippe*	(Walker)	Germany		
Eulophidae	*Aprostocetus mandanis*	(Walker)	Germany		2001
Eulophidae	*Aprostocetus metra*	(Walker)	Germany		
Eulophidae	*Aprostocetus microscopicus*	(Rondani)	Germany		
Eulophidae	*Aprostocetus minimus*	(Ratzeburg)	Germany		
Eulophidae	*Aprostocetus mycerinus*	(Walker)	Germany		
Eulophidae	*Aprostocetus neglectus*	(Domenichini)	Germany		
Eulophidae	*Aprostocetus novatus*	(Walker)	Germany		
Eulophidae	*Aprostocetus orithyia*	(Walker)	Germany		
Eulophidae	*Aprostocetus ovivorax*	(Silvestri)	Germany		
Eulophidae	*Aprostocetus pachyneuros*	(Ratzeburg)	Germany		
Eulophidae	*Aprostocetus pallipes*	(Dalman)	Germany		
Eulophidae	*Aprostocetus pausiris*	(Walker)	Germany		
Eulophidae	*Aprostocetus percaudatus*	(Silvestri)	Germany		
Eulophidae	*Aprostocetus phineus*	(Walker)	Germany		2001
Eulophidae	*Aprostocetus phragmiticola*	Graham	Germany		2001
Eulophidae	*Aprostocetus pseudopodiellus*	(Bakkendorf)	Germany		
Eulophidae	*Aprostocetus ptarmicae*	Graham	Germany		2001
Eulophidae	*Aprostocetus pygmaeus*	(Zetterstedt)	Germany		
Eulophidae	*Aprostocetus roesellae*	(Nees)	Germany		
Eulophidae	*Aprostocetus rubi*	Graham	Germany		
Eulophidae	*Aprostocetus rubicola*	Graham	Germany		2001
Eulophidae	*Aprostocetus rumicis*	Graham	Germany		2001
Eulophidae	*Aprostocetus salictorum*	Graham	Germany		
Eulophidae	*Aprostocetus serratularum*	Graham	Germany		
Eulophidae	*Aprostocetus strobilanae*	(Ratzeburg)	Germany		
Eulophidae	*Aprostocetus subplanus*	Graham	Germany		2001
Eulophidae	*Aprostocetus tanaceticola*	Graham	Germany		

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Eulophidae	*Aprostocetus terebrans*	Erdös	Germany		2001
Eulophidae	*Aprostocetus trjapitzini*	(Kostjukov)	Germany		
Eulophidae	*Aprostocetus vassolensis*	Graham	Germany		2001
Eulophidae	*Aprostocetus venustus*	(Gahan)	Germany		
Eulophidae	*Aprostocetus veronicae*	Graham	Germany		2010
Eulophidae	*Aprostocetus xanthopus*	(Nees)	Germany		
Eulophidae	*Aprostocetus zosimus*	(Walker)	Germany		
Eulophidae	*Asecodes congruens*	(Nees)	Germany		2001
Eulophidae	*Asecodes erxias*	(Walker)	Germany		
Eulophidae	*Asecodes lagus*	(Walker)	Germany		2001
Eulophidae	*Asecodes lucens*	(Nees)	Germany		
Eulophidae	*Asecodes turcicum*	(Nees)	Germany		
Eulophidae	*Astichus arithmeticus*	(Förster)	Germany		
Eulophidae	*Astichus maculatus*	Hedqvist	Germany		
Eulophidae	*Astichus solutus*	Förster	Germany		
Eulophidae	*Aulogymnus aceris*	Förster	Germany		
Eulophidae	*Aulogymnus arsames*	(Walker)	Germany		
Eulophidae	*Aulogymnus euedoreschus*	(Walker)	Germany		
Eulophidae	*Aulogymnus fumatus*	(Ratzeburg)	Germany		
Eulophidae	*Aulogymnus gallarum*	(Linnaeus)	Germany		
Eulophidae	*Aulogymnus obscuripes*	(Mayr)	Germany		2013
Eulophidae	*Aulogymnus skianeuros*	(Ratzeburg)	Germany		
Eulophidae	*Baryscapus adalia*	(Walker)	Germany		
Eulophidae	*Baryscapus agrilorum*	(Ratzeburg)	Germany		
Eulophidae	*Baryscapus anasillus*	Graham	Germany		2013
Eulophidae	*Baryscapus bonessi*	Askew	Germany		
Eulophidae	*Baryscapus bruchophagi*	(Gahan)	Germany		2001
Eulophidae	*Baryscapus conwentziae*	(Ferrière)	Germany		
Eulophidae	*Baryscapus crassicornis*	(Erdös)	Germany		
Eulophidae	*Baryscapus daira*	(Walker)	Germany		
Eulophidae	*Baryscapus diaphantus*	(Walker)	Germany		2013
Eulophidae	*Baryscapus endemus*	(Walker)	Germany		
Eulophidae	*Baryscapus evonymellae*	(Bouché)	Germany		
Eulophidae	*Baryscapus galactopus*	(Ratzeburg)	Germany		
Eulophidae	*Baryscapus garganus*	(Domenichini)	Germany		
Eulophidae	*Baryscapus gradwelli*	Graham	Germany		
Eulophidae	*Baryscapus impeditus*	(Nees)	Germany		
Eulophidae	*Baryscapus lotellae*	(Delucchi)	Germany		
Eulophidae	*Baryscapus nigroviolaceus*	(Nees)	Germany		
Eulophidae	*Baryscapus oophagus*	(Otten)	Germany		
Eulophidae	*Baryscapus pallidae*	Graham	Germany		2013

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Eulophidae	*Baryscapus servadeii*	(Domenichini)	Germany		1993
Eulophidae	*Baryscapus spartifoliellae*	Graham	Germany		
Eulophidae	*Baryscapus sugonjaevi*	(Kostjukov)	Germany		
Eulophidae	*Baryscapus turionum*	(Hartig)	Germany		
Eulophidae	*Ceranisus menes*	(Walker)	Germany	2011	
Eulophidae	*Ceranisus pacuvius*	(Walker)	Germany	2011	
Eulophidae	*Chaenotetrastichus grangeri*	(Erdös)	Germany		
Eulophidae	*Chaenotetrastichus semiflavus*	(Girault)	Germany	1996	
Eulophidae	*Chrysocharis acoris*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis acutigaster*	Hansson	Germany	1985	2001
Eulophidae	*Chrysocharis amasis*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis amyite*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis antoni*	Hansson	Germany	1985	
Eulophidae	*Chrysocharis assis*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis avia*	Hansson	Germany	1985	2001
Eulophidae	*Chrysocharis budensis*	Erdös	Germany	1985	
Eulophidae	*Chrysocharis chlorus*	Graham	Germany	1985	
Eulophidae	*Chrysocharis clarkae*	Yoshimoto	Germany	1985	2001
Eulophidae	*Chrysocharis crassiscapus*	(Thomson)	Germany	1985	
Eulophidae	*Chrysocharis elongata*	(Thomson)	Germany	1985	
Eulophidae	*Chrysocharis entedonoides*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis equiseti*	Hansson	Germany	1985	2001
Eulophidae	*Chrysocharis eurynota*	Graham	Germany	1985	2001
Eulophidae	*Chrysocharis foliincolarum*	(Christ)	Germany	1985	2001
Eulophidae	*Chrysocharis gemma*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis idyia*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis illustris*	Graham	Germany	1985	
Eulophidae	*Chrysocharis laomedon*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis laricinellae*	(Ratzeburg)	Germany	1985	
Eulophidae	*Chrysocharis liriomyzae*	Delucchi	Germany	1985	
Eulophidae	*Chrysocharis mediana*	Förster	Germany	1985	2001
Eulophidae	*Chrysocharis nautius*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis nephereus*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis nigricrus*	(Thomson)	Germany	1985	
Eulophidae	*Chrysocharis nitetis*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis nitidifrons*	Graham	Germany	1985	2001
Eulophidae	*Chrysocharis orbicularis*	(Nees)	Germany	1985	
Eulophidae	*Chrysocharis pallipes*	(Nees)	Germany	1985	
Eulophidae	*Chrysocharis pentheus*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis phryne*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis pilosa*	Delucchi	Germany	1985	

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Eulophidae	*Chrysocharis polyzo*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis prodice*	(Walker)	Germany	1985	
Eulophidae	*Chrysocharis pubens*	Delucchi	Germany	1985	
Eulophidae	*Chrysocharis pubicornis*	(Zetterstedt)	Germany	1985	
Eulophidae	*Chrysocharis purpurea*	Bukovskii	Germany	1985	
Eulophidae	*Chrysocharis submutica*	Graham	Germany	1985	
Eulophidae	*Chrysocharis viridis*	(Nees)	Germany	1985	
Eulophidae	*Chrysonotomyia germanica*	(Erdös)	Germany	1990	
Eulophidae	*Cirrospilus argei*	(Crawford)	Germany		2001
Eulophidae	*Cirrospilus diallus*	Walker	Germany		
Eulophidae	*Cirrospilus elegantissimus*	Westwood	Germany		
Eulophidae	*Cirrospilus elongatus*	Bouček	Germany		
Eulophidae	*Cirrospilus lyncus*	Walker	Germany		
Eulophidae	*Cirrospilus pictus*	(Nees)	Germany		
Eulophidae	*Cirrospilus salatis*	Walker	Germany		
Eulophidae	*Cirrospilus singa*	Walker	Germany		
Eulophidae	*Cirrospilus staryi*	Bouček	Germany		1959
Eulophidae	*Cirrospilus viticola*	(Rondani)	Germany		
Eulophidae	*Cirrospilus vittatus*	Walker	Germany	1984	
Eulophidae	*Closterocerus lanassa*	(Walker)	Germany		
Eulophidae	*Closterocerus lyonetiae*	(Ferrière)	Germany		
Eulophidae	*Closterocerus pannonicus*	(Erdös)	Germany		2001
Eulophidae	*Closterocerus ruforum*	(Krausse)	Germany		
Eulophidae	*Closterocerus trifasciatus*	Westwood	Germany		
Eulophidae	*Colpoclypeus florus*	(Walker)	Germany		
Eulophidae	*Crataepus marbis*	(Walker)	Germany		
Eulophidae	*Dahlbominus fuscipennis*	(Zetterstedt)	Germany		
Eulophidae	*Dermatopelte budensis*	Erdös & Novicky	Germany		
Eulophidae	*Derostenus gemmeus*	Westwood	Germany	2003	
Eulophidae	*Derostenus punctiscuta*	Thomson	Germany	2003	
Eulophidae	*Dichatomus acerinus*	Förster	Germany		
Eulophidae	*Dicladocerus albitarsis*	(Ashmead)	Germany		
Eulophidae	*Dicladocerus euryalus*	(Haliday)	Germany	1987	
Eulophidae	*Dicladocerus westwoodii*	Westwood	Germany		
Eulophidae	*Diglyphus chabrias*	(Walker)	Germany		
Eulophidae	*Diglyphus crassinervis*	Erdös	Germany		
Eulophidae	*Diglyphus isaea*	(Walker)	Germany		
Eulophidae	*Diglyphus minoeus*	(Walker)	Germany		
Eulophidae	*Diglyphus pachyneurus*	Graham	Germany		
Eulophidae	*Diglyphus poppoea*	Walker	Germany		
Eulophidae	*Diglyphus pusztensis*	(Erdös & Novicky)	Germany		2001

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Eulophidae	*Diglyphus subplanus*	(Erdös)	Germany		
Eulophidae	*Dimmockia brevicornis*	(Erdös)	Germany		
Eulophidae	*Elachertus aequalis*	Förster	Germany	1964	
Eulophidae	*Elachertus aeruginosus*	Förster	Germany	1964	
Eulophidae	*Elachertus artaeus*	(Walker)	Germany	1964	
Eulophidae	*Elachertus charondas*	(Walker)	Germany	1964	
Eulophidae	*Elachertus coerulescens*	Nees	Germany	1964	
Eulophidae	*Elachertus cyaneus*	Förster	Germany	1964	
Eulophidae	*Elachertus deplanatus*	(Ratzeburg)	Germany	1964	
Eulophidae	*Elachertus ditissimus*	Förster	Germany	1964	
Eulophidae	*Elachertus facialis*	Förster	Germany	1964	
Eulophidae	*Elachertus fenestratus*	Nees	Germany	1964	
Eulophidae	*Elachertus gallicus*	Erdös	Germany	1964	
Eulophidae	*Elachertus inunctus*	Nees	Germany	1964	
Eulophidae	*Elachertus isadas*	(Walker)	Germany	1964	
Eulophidae	*Elachertus laevis*	(Förster)	Germany	1964	
Eulophidae	*Elachertus lateralis*	(Spinola)	Germany	1964	
Eulophidae	*Elachertus lunatus*	Förster	Germany	1964	1968
Eulophidae	*Elachertus pilosiscuta*	Bouček	Germany	1964	
Eulophidae	*Elachertus plagiatus*	Förster	Germany	1964	
Eulophidae	*Elachertus pulcher*	(Erdös)	Germany	1964	2001
Eulophidae	*Elachertus reticulatus*	Ratzeburg	Germany	1964	
Eulophidae	*Elachertus timidus*	Förster	Germany	1964	2001
Eulophidae	*Elachertus walkeri*	(Ratzeburg)	Germany	1964	
Eulophidae	*Elasmus flabellatus*	(Fonscolombe)	Germany	1995	
Eulophidae	*Elasmus nudus*	(Nees)	Germany	1995	
Eulophidae	*Elasmus polistis*	Burks	Germany	1995	1972
Eulophidae	*Elasmus schmitti*	Ruschka	Germany	1995	
Eulophidae	*Elasmus unicolor*	(Rondani)	Germany	1995	
Eulophidae	*Elasmus viridiceps*	Thomson	Germany	1995	2001
Eulophidae	*Elasmus westwoodi*	Giraud	Germany	1995	
Eulophidae	*Entedon abdera*	Walker	Germany	1999	2001
Eulophidae	*Entedon aequilongus*	Ratzeburg	Germany	1999	
Eulophidae	*Entedon calcicola*	Graham	Germany	1999	2001
Eulophidae	*Entedon canaliculatus*	(Förster)	Germany	1999	1968
Eulophidae	*Entedon caudatus*	Ratzeburg	Germany	1999	
Eulophidae	*Entedon cavicornis*	Ratzeburg	Germany	1999	
Eulophidae	*Entedon chalybaeus*	Ratzeburg	Germany	1999	
Eulophidae	*Entedon cioni*	Thomson	Germany	1999	
Eulophidae	*Entedon cionobius*	Thomson	Germany	1999	
Eulophidae	*Entedon confinis*	Ratzeburg	Germany	1999	2001

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Eulophidae	*Entedon connexus*	Ratzeburg	Germany	1999	
Eulophidae	*Entedon costalis*	Dalman	Germany	1999	
Eulophidae	*Entedon crassiscapus*	Erdös	Germany	1999	
Eulophidae	*Entedon diotimus*	Walker	Germany	1999	
Eulophidae	*Entedon ergias*	Walker	Germany	1999	
Eulophidae	*Entedon gracilior*	Graham	Germany	1999	
Eulophidae	*Entedon heyeri*	(Ratzeburg)	Germany	1999	
Eulophidae	*Entedon hylotomarum*	(Ratzeburg)	Germany	1999	2001
Eulophidae	*Entedon inconspicuus*	Ratzeburg	Germany	1999	2001
Eulophidae	*Entedon incultus*	Askew	Germany	1999	2001
Eulophidae	*Entedon insignis*	Erdös	Germany	1999	
Eulophidae	*Entedon lixi*	Erdös	Germany	1999	2001
Eulophidae	*Entedon longiventris*	Ratzeburg	Germany	1999	
Eulophidae	*Entedon longus*	Bouček	Germany	1999	2001
Eulophidae	*Entedon luteipes*	Ratzeburg	Germany	1999	
Eulophidae	*Entedon mecini*	Askew	Germany	1999	2003
Eulophidae	*Entedon methion*	Walker	Germany	1999	
Eulophidae	*Entedon oxys*	Askew	Germany	1999	2001
Eulophidae	*Entedon parvicalcar*	Thomson	Germany	1999	
Eulophidae	*Entedon philiscus*	Walker	Germany	1999	2001
Eulophidae	*Entedon pinetorum*	Ratzeburg	Germany	1999	
Eulophidae	*Entedon procioni*	Erdös	Germany	1999	2001
Eulophidae	*Entedon punctiscapus*	Thomson	Germany	1999	
Eulophidae	*Entedon rumicis*	Graham	Germany	1999	
Eulophidae	*Entedon setifrons*	Askew	Germany	1999	2001
Eulophidae	*Entedon tenuitarsis*	Thomson	Germany	1999	
Eulophidae	*Entedon thomsonianus*	Erdös	Germany	1999	
Eulophidae	*Entedon tibialis*	(Nees)	Germany	1999	
Eulophidae	*Entedon transparens*	Ratzeburg	Germany	1999	
Eulophidae	*Entedon unicostatus*	Ratzeburg	Germany	1999	
Eulophidae	*Entedon vaginulae*	Ratzeburg	Germany	1999	2001
Eulophidae	*Entedon xanthostoma*	(Ratzeburg)	Germany	1999	
Eulophidae	*Entedon zanara*	Walker	Germany	1999	
Eulophidae	*Entedonomphale bicolorata*	(Ishii)	Germany		
Eulophidae	*Entedonomphale carbonaria*	(Erdös)	Germany		
Eulophidae	*Euderomphale chelidonii*	Erdös	Germany		1966
Eulophidae	*Euderus agrili*	Bouček	Germany		2001
Eulophidae	*Euderus albitarsis*	(Zetterstedt)	Germany		
Eulophidae	*Euderus viridis*	Thomson	Germany		2001
Eulophidae	*Eulophus abdominalis*	Nees	Germany		
Eulophidae	*Eulophus albitarsus*	Ratzeburg	Germany		

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Eulophidae	*Eulophus bifasciatus*	Nees	Germany		
Eulophidae	*Eulophus binotatus*	Förster	Germany		
Eulophidae	*Eulophus blancardellae*	Bouché	Germany		
Eulophidae	*Eulophus breviramulis*	Förster	Germany		
Eulophidae	*Eulophus cecidomyiarum*	Ratzeburg	Germany		
Eulophidae	*Eulophus cephalotes*	Nees	Germany		
Eulophidae	*Eulophus chrysomelae*	Nees	Germany		2001
Eulophidae	*Eulophus coccorum*	Ratzeburg	Germany		
Eulophidae	*Eulophus cyanescens*	Bouček	Germany		2001
Eulophidae	*Eulophus depressus*	Nees	Germany		
Eulophidae	*Eulophus dubitabilis*	Förster	Germany		
Eulophidae	*Eulophus emicans*	Nees	Germany		
Eulophidae	*Eulophus foveolatus*	Nees	Germany		
Eulophidae	*Eulophus inconspicuus*	Nees	Germany		
Eulophidae	*Eulophus larvarum*	(Linnaeus)	Germany		
Eulophidae	*Eulophus nitidulus*	Nees	Germany		
Eulophidae	*Eulophus pennicornis*	Nees	Germany		
Eulophidae	*Eulophus polycerus*	Förster	Germany		
Eulophidae	*Eulophus ramicornis*	(Fabricius)	Germany		1963
Eulophidae	*Eulophus rupicapra*	Förster	Germany		
Eulophidae	*Eulophus semicupreus*	Nees	Germany		
Eulophidae	*Eulophus smerinthicida*	Bouček	Germany		
Eulophidae	*Eulophus tabidus*	Nees	Germany		
Eulophidae	*Eulophus thespius*	Walker	Germany		
Eulophidae	*Eulophus vagus*	Nees	Germany		
Eulophidae	*Euplectrus bicolor*	(Swederus)	Germany		
Eulophidae	*Hemiptarsenus fulvicollis*	Westwood	Germany	2003	
Eulophidae	*Hemiptarsenus ornatus*	(Nees)	Germany	2003	
Eulophidae	*Hemiptarsenus unguicellus*	(Zetterstedt)	Germany	2003	
Eulophidae	*Hemiptarsenus wailesellae*	Nowicki	Germany	2003	
Eulophidae	*Hemiptarsenus waterhousii*	Westwood	Germany	2003	2001
Eulophidae	*Holarcticesa clinius*	(Walker)	Germany		
Eulophidae	*Holcotetrastichus rhosaces*	(Walker)	Germany		
Eulophidae	*Hyssopus geniculatus*	(Hartig)	Germany		
Eulophidae	*Hyssopus nigritulus*	(Zetterstedt)	Germany		
Eulophidae	*Hyssopus olivaceus*	(Thomson)	Germany		
Eulophidae	*Hyssopus tephridus*	Yefremova	Germany		2001
Eulophidae	*Hyssopus thymus*	Girault	Germany		
Eulophidae	*Kocourekia debilis*	(Ratzeburg)	Germany		
Eulophidae	*Melittobia acasta*	(Walker)	Germany		
Eulophidae	*Mestocharis bimacularis*	(Dalman)	Germany	1988	

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Eulophidae	*Mestocharis maculata*	(Förster)	Germany	1988	
Eulophidae	*Microlycus biroi*	Erdös	Germany		2001
Eulophidae	*Microlycus heterocerus*	Thomson	Germany		
Eulophidae	*Minotetrastichus frontalis*	(Nees)	Germany		
Eulophidae	*Minotetrastichus platanellus*	(Mercet)	Germany		
Eulophidae	*Minotetrastichus prolongatus*	Graham	Germany		2001
Eulophidae	*Miotropis unipuncta*	(Nees)	Germany		
Eulophidae	*Necremnus aenigmaticus*	Gibson	Germany	2015	2015
Eulophidae	*Necremnus artynes*	(Walker)	Germany	2015	2001
Eulophidae	*Necremnus cosconius*	(Walker)	Germany	2015	2001
Eulophidae	*Necremnus folia*	(Walker)	Germany	2015	
Eulophidae	*Necremnus leucarthros*	(Nees)	Germany	2015	
Eulophidae	*Necremnus metalarus*	(Walker)	Germany	2015	
Eulophidae	*Necremnus tidius*	(Walker)	Germany	2015	
Eulophidae	*Neochrysocharis albiscapus*	Erdös	Germany	1990	
Eulophidae	*Neochrysocharis aratus*	(Walker)	Germany	1990	
Eulophidae	*Neochrysocharis chlorogaster*	(Erdös)	Germany	1990	
Eulophidae	*Neochrysocharis clinias*	(Walker)	Germany	1990	2001
Eulophidae	*Neochrysocharis cuprifrons*	Erdös	Germany	1990	2001
Eulophidae	*Neochrysocharis dimas*	(Walker)	Germany	1990	2001
Eulophidae	*Neochrysocharis formosus*	(Westwood)	Germany	1990	
Eulophidae	*Neochrysocharis microstoma*	(Graham)	Germany	1990	
Eulophidae	*Neochrysocharis nunbergi*	(Szczepanski)	Germany	1990	
Eulophidae	*Omphale acuminata*	Gijswijt	Germany		2012
Eulophidae	*Omphale aethiops*	Graham	Germany		
Eulophidae	*Omphale aetius*	(Walker)	Germany		
Eulophidae	*Omphale betulicola*	Graham	Germany		2001
Eulophidae	*Omphale brevis*	Graham	Germany		
Eulophidae	*Omphale breviventris*	Graham	Germany		
Eulophidae	*Omphale chryseis*	Graham	Germany		
Eulophidae	*Omphale clymene*	(Walker)	Germany		
Eulophidae	*Omphale clypealis*	(Thomson)	Germany		
Eulophidae	*Omphale connectens*	Graham	Germany		
Eulophidae	*Omphale grahami*	Gijswijt	Germany		
Eulophidae	*Omphale incognita*	Hansson & Shevtsova	Germany		2012
Eulophidae	*Omphale lugens*	(Nees)	Germany		
Eulophidae	*Omphale lugubris*	Askew	Germany		
Eulophidae	*Omphale matrana*	Erdös	Germany		
Eulophidae	*Omphale nitens*	Graham	Germany		2001
Eulophidae	*Omphale obscura*	(Förster)	Germany		
Eulophidae	*Omphale phruron*	(Walker)	Germany		

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family	species	author	distribution	revision (year)	single record (year)
Eulophidae	*Omphale rubigus*	(Walker)	Germany		
Eulophidae	*Omphale salicis*	(Haliday)	Germany		
Eulophidae	*Omphale stelteri*	(Bouček)	Germany		
Eulophidae	*Omphale sulciscuta*	(Thomson)	Germany		
Eulophidae	*Omphale telephe*	(Walker)	Germany		2012
Eulophidae	*Omphale theana*	(Walker)	Germany		
Eulophidae	*Omphale varipes*	(Thomson)	Germany		
Eulophidae	*Omphale versicolor*	(Nees)	Germany		
Eulophidae	*Oomyzus galerucivorus*	(Hedqvist)	Germany		
Eulophidae	*Oomyzus gallerucae*	(Fonscolombe)	Germany		
Eulophidae	*Oomyzus incertus*	(Ratzeburg)	Germany		
Eulophidae	*Oomyzus pegomyae*	Graham	Germany		
Eulophidae	*Oomyzus scaposus*	(Thomson)	Germany		
Eulophidae	*Oomyzus sempronius*	(Erdös)	Germany		2001
Eulophidae	*Parasecodella obscura*	(Thomson)	Germany		2001
Eulophidae	*Pediobius alaspharus*	(Walker)	Germany		
Eulophidae	*Pediobius alcaeus*	(Walker)	Germany	2003	
Eulophidae	*Pediobius brachycerus*	(Thomson)	Germany		
Eulophidae	*Pediobius calamagrostidis*	Dawah	Germany		
Eulophidae	*Pediobius cassidae*	Erdös	Germany		
Eulophidae	*Pediobius chilaspidis*	Bouček	Germany		2001
Eulophidae	*Pediobius claridgei*	Dawah	Germany		2001
Eulophidae	*Pediobius clita*	(Walker)	Germany		
Eulophidae	*Pediobius crassicornis*	(Thomson)	Germany		
Eulophidae	*Pediobius dactylicola*	Dawah	Germany		2001
Eulophidae	*Pediobius epeus*	(Walker)	Germany		
Eulophidae	*Pediobius epigonus*	(Walker)	Germany		
Eulophidae	*Pediobius eubius*	(Walker)	Germany		
Eulophidae	*Pediobius facialis*	(Giraud)	Germany		
Eulophidae	*Pediobius festucae*	Dawah	Germany		2001
Eulophidae	*Pediobius flaviscapus*	(Thomson)	Germany		
Eulophidae	*Pediobius foliorum*	(Geoffroy)	Germany		
Eulophidae	*Pediobius lysis*	(Walker)	Germany		
Eulophidae	*Pediobius metallicus*	(Nees)	Germany		
Eulophidae	*Pediobius nigritarsis*	(Thomson)	Germany		
Eulophidae	*Pediobius phalaridis*	Dawah	Germany		2001
Eulophidae	*Pediobius phragmitis*	Bouček	Germany		2001
Eulophidae	*Pediobius phyllotretae*	(Riley)	Germany		
Eulophidae	*Pediobius planiventris*	(Thomson)	Germany		
Eulophidae	*Pediobius polanensis*	Bouček	Germany		2001
Eulophidae	*Pediobius pyrgo*	(Walker)	Germany	1995	

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Eulophidae	*Pediobius saulius*	(Walker)	Germany		
Eulophidae	*Pediobius termerus*	(Walker)	Germany		2001
Eulophidae	*Pediobius tetratomus*	(Thomson)	Germany		
Eulophidae	*Platyplectrus chlorocephalus*	(Nees)	Germany		
Eulophidae	*Platyplectrus laeviscuta*	(Thomson)	Germany		
Eulophidae	*Platyplectrus pannonica*	(Erdös)	Germany		
Eulophidae	*Pnigalio agraules*	(Walker)	Germany	1984	
Eulophidae	*Pnigalio cristatus*	(Ratzeburg)	Germany	1984	
Eulophidae	*Pnigalio cruciatus*	(Ratzeburg)	Germany	1984	
Eulophidae	*Pnigalio epilobii*	Bouček	Germany	1984	
Eulophidae	*Pnigalio longulus*	(Zetterstedt)	Germany	1984	
Eulophidae	*Pnigalio monilicornis*	(Zetterstedt)	Germany	1984	2001
Eulophidae	*Pnigalio nemati*	(Westwood)	Germany	1984	
Eulophidae	*Pnigalio obscurus*	(Ratzeburg)	Germany	1984	
Eulophidae	*Pnigalio pectinicornis*	(Linnaeus)	Germany	1984	
Eulophidae	*Pnigalio phragmitis*	(Erdös)	Germany	1984	2001
Eulophidae	*Pnigalio soemius*	(Walker)	Germany	1984	
Eulophidae	*Pnigalio tardulus*	(Nees)	Germany	1984	
Eulophidae	*Pnigalio tricuspis*	(Erdös)	Germany	1984	
Eulophidae	*Pnigalio tridentatus*	(Thomson)	Germany	1984	2007
Eulophidae	*Pronotalia carlinarum*	(Szelényi & Erdös)	Germany		
Eulophidae	*Pronotalia inflata*	Graham	Germany		2001
Eulophidae	*Quadrastichus misellus*	(Delucchi)	Germany		
Eulophidae	*Quadrastichus pedicellaris*	(Thomson)	Germany		
Eulophidae	*Quadrastichus sajoi*	(Szelényi)	Germany		
Eulophidae	*Rhicnopelte crassicornis*	(Nees)	Germany		
Eulophidae	*Sigmophora brevicornis*	(Panzer)	Germany		
Eulophidae	*Sphenolepis pygmaea*	Nees	Germany		
Eulophidae	*Stenomesius rufescens*	(Retzius)	Germany		
Eulophidae	*Stepanovia aurantiaca*	(Ratzeburg)	Germany		
Eulophidae	*Stepanovia eurytomae*	(Nees)	Germany		
Eulophidae	*Sympiesis acalle*	(Walker)	Germany		
Eulophidae	*Sympiesis dolichogaster*	Ashmead	Germany	1977	2001
Eulophidae	*Sympiesis euspilapterygis*	(Erdös)	Germany		2001
Eulophidae	*Sympiesis flavopicta*	Bouček	Germany		
Eulophidae	*Sympiesis gordius*	(Walker)	Germany		
Eulophidae	*Sympiesis grahami*	Erdös	Germany		
Eulophidae	*Sympiesis gregori*	Bouček	Germany		2001
Eulophidae	*Sympiesis kelebiana*	Erdös	Germany		2001
Eulophidae	*Sympiesis notata*	(Zetterstedt)	Germany		
Eulophidae	*Sympiesis sericeicornis*	(Nees)	Germany		

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Eulophidae	*Sympiesis solitaria*	Szelényi	Germany		2005
Eulophidae	*Sympiesis viridula*	(Thomson)	Germany		
Eulophidae	*Sympiesis xanthostoma*	(Nees)	Germany		
Eulophidae	*Tamarixia actis*	(Walker)	Germany		
Eulophidae	*Tamarixia monesus*	(Walker)	Germany		
Eulophidae	*Tamarixia pronomus*	(Walker)	Germany		
Eulophidae	*Tamarixia pubescens*	(Nees)	Germany		
Eulophidae	*Tamarixia upis*	(Walker)	Germany		
Eulophidae	*Tetrastichus atratulus*	(Nees)	Germany	1953	
Eulophidae	*Tetrastichus atrocoeruleus*	(Nees)	Germany	1953	2001
Eulophidae	*Tetrastichus brachyopae*	Graham	Germany	1953	
Eulophidae	*Tetrastichus capitatus*	(Ratzeburg)	Germany	1953	2001
Eulophidae	*Tetrastichus clito*	(Walker)	Germany	1953	
Eulophidae	*Tetrastichus coeruleus*	(Nees)	Germany	1953	
Eulophidae	*Tetrastichus halidayi*	(Graham)	Germany	1953	
Eulophidae	*Tetrastichus heeringi*	Delucchi	Germany	1953	
Eulophidae	*Tetrastichus hylotomarum*	(Bouché)	Germany	1953	
Eulophidae	*Tetrastichus ilithyia*	(Walker)	Germany	1953	
Eulophidae	*Tetrastichus inunctus*	(Nees)	Germany	1953	2001
Eulophidae	*Tetrastichus julis*	(Walker)	Germany	1953	
Eulophidae	*Tetrastichus legionarius*	Giraud	Germany	1953	
Eulophidae	*Tetrastichus lyridice*	(Walker)	Germany	1953	2001
Eulophidae	*Tetrastichus miser*	(Nees)	Germany	1953	
Eulophidae	*Tetrastichus murcia*	(Walker)	Germany	1953	
Eulophidae	*Tetrastichus ooctonus*	(Kawall)	Germany	1953	
Eulophidae	*Tetrastichus polyporinus*	Askew	Germany	1953	2007
Eulophidae	*Tetrastichus setifer*	Thomson	Germany	1953	2002
Eulophidae	*Tetrastichus sinope*	(Walker)	Germany	1953	1963
Eulophidae	*Tetrastichus telon*	(Graham)	Germany	1953	
Eulophidae	*Thripastichus gentilei*	(Del Guercio)	Germany		1966
Eulophidae	*Trjapitzinichus evanescens*	(Ratzeburg)	Germany		
Eulophidae	*Xanthellum szabopatayi*	Moczár	Germany		
Eupelmidae	*Anastatus bifasciatus*	(Geoffroy)	Germany		
Eupelmidae	*Anastatus catalonicus*	Bolivar y Pieltain	Germany		
Eupelmidae	*Anastatus giraudi*	(Ruschka)	Germany		2001
Eupelmidae	*Anastatus insignis*	(Förster)	Germany		2001
Eupelmidae	*Anastatus japonicus*	Ashmead	Germany		
Eupelmidae	*Anastatus oscari*	(Ruthe)	Germany		
Eupelmidae	*Brasema stenus*	(Bouček)	Germany	2006	
Eupelmidae	*Calosota acron*	(Walker)	Germany	2010	2001
Eupelmidae	*Calosota grylli*	Erdös	Germany	2010	1993

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Eupelmidae	*Calosota metallica*	(Gahan)	Germany	2010	2001
Eupelmidae	*Calosota obscura*	Ruschka	Germany	2010	2001
Eupelmidae	*Calosota vernalis*	Curtis	Germany	2010	
Eupelmidae	*Calymmochilus dispar*	Bouček & Andriescu	Germany		
Eupelmidae	*Eupelmus annulatus*	Nees	Germany	2016	
Eupelmidae	*Eupelmus atropurpureus*	Dalman	Germany	2016	
Eupelmidae	*Eupelmus azureus*	Ratzeburg	Germany	2016	
Eupelmidae	*Eupelmus brachynterae*	(Schwägrichen)	Germany	2016	2001
Eupelmidae	*Eupelmus fuscipennis*	Förster	Germany	2016	
Eupelmidae	*Eupelmus hartigi*	Förster	Germany	2016	
Eupelmidae	*Eupelmus linearis*	Förster	Germany	2016	2001
Eupelmidae	*Eupelmus microzonus*	Förster	Germany	2016	
Eupelmidae	*Eupelmus splendens*	Giraud	Germany	2016	2006
Eupelmidae	*Eupelmus stramineipes*	Nikol'skaya	Germany	2016	2001
Eupelmidae	*Eupelmus urozonus*	Dalman	Germany	2016	
Eupelmidae	*Eupelmus vesicularis*	(Retzius)	Germany	2016	
Eupelmidae	*Eusandalum coronatum*	(Thomson)	Germany	1967	
Eupelmidae	*Eusandalum elongatum*	(Ruschka)	Germany	1967	
Eupelmidae	*Eusandalum flavipenne*	Ruschka	Germany	1967	
Eupelmidae	*Eusandalum inerme*	(Ratzeburg)	Germany	1967	
Eupelmidae	*Eusandalum walkeri*	(Curtis)	Germany	1967	2001
Eupelmidae	*Merostenus excavatus*	(Dalman)	Germany		
Eupelmidae	*Merostenus rostratus*	(Ruschka)	Germany	2017	2001
Eupelmidae	*Metapelma nobile*	(Förster)	Germany		
Eurytomidae	*Aximopsis nodularis*	(Boheman)	Germany		
Eurytomidae	*Bruchophagus astragali*	Fedoseeva	Germany		2001
Eurytomidae	*Bruchophagus ater*	(Walker)	Germany		2001
Eurytomidae	*Bruchophagus gibbus*	(Boheman)	Germany		
Eurytomidae	*Bruchophagus phlei*	(Erdös)	Germany		2001
Eurytomidae	*Bruchophagus platypterus*	(Walker)	Germany		
Eurytomidae	*Bruchophagus roddi*	Gussakovskiy	Germany		
Eurytomidae	*Eurytoma abieticola*	Ratzeburg	Germany		2001
Eurytomidae	*Eurytoma abrotani*	(Panzer)	Germany		2001
Eurytomidae	*Eurytoma aciculata*	Ratzeburg	Germany		
Eurytomidae	*Eurytoma adleriae*	Zerova	Germany		2013
Eurytomidae	*Eurytoma afra*	Boheman	Germany		
Eurytomidae	*Eurytoma aloineae*	(Burks)	Germany		1958
Eurytomidae	*Eurytoma appendigaster*	(Swederus)	Germany	1959	2001
Eurytomidae	*Eurytoma aquatica*	Erdös	Germany		2001
Eurytomidae	*Eurytoma arctica*	Thomson	Germany		
Eurytomidae	*Eurytoma aspila*	(Walker)	Germany		

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Eurytomidae	*Eurytoma aterrima*	(Schrank)	Germany		
Eurytomidae	*Eurytoma baldingerae*	Erdös	Germany		2001
Eurytomidae	*Eurytoma brunniventris*	Ratzeburg	Germany		
Eurytomidae	*Eurytoma castor*	Claridge	Germany		2001
Eurytomidae	*Eurytoma caulicola*	Zerova	Germany		2001
Eurytomidae	*Eurytoma centaureae*	Claridge	Germany		
Eurytomidae	*Eurytoma collaris*	Walker	Germany		
Eurytomidae	*Eurytoma compressa*	(Fabricius)	Germany		
Eurytomidae	*Eurytoma coxalis*	Erdös	Germany		2001
Eurytomidae	*Eurytoma crassinervis*	Thomson	Germany		
Eurytomidae	*Eurytoma curculionum*	Mayr	Germany		
Eurytomidae	*Eurytoma curta*	Walker	Germany		2001
Eurytomidae	*Eurytoma cynipsea*	Boheman	Germany		
Eurytomidae	*Eurytoma danilovi*	Zerova	Germany		2001
Eurytomidae	*Eurytoma danuvica*	Erdös	Germany		
Eurytomidae	*Eurytoma dentata*	Mayr	Germany		
Eurytomidae	*Eurytoma erdoesi*	Szelényi	Germany		2001
Eurytomidae	*Eurytoma extincta*	Ratzeburg	Germany		2001
Eurytomidae	*Eurytoma flavimana*	Boheman	Germany		2001
Eurytomidae	*Eurytoma goidanichi*	Bouček	Germany		
Eurytomidae	*Eurytoma gracilior*	Dalla Torre	Germany		2001
Eurytomidae	*Eurytoma hypochoeridis*	Claridge	Germany		2006
Eurytomidae	*Eurytoma jaceae*	Mayr	Germany		
Eurytomidae	*Eurytoma kangasi*	Hedqvist	Germany		2001
Eurytomidae	*Eurytoma maura*	Boheman	Germany		
Eurytomidae	*Eurytoma mayri*	Ashmead	Germany		
Eurytomidae	*Eurytoma microneura*	Ratzeburg	Germany		2001
Eurytomidae	*Eurytoma morio*	Boheman	Germany	2014	
Eurytomidae	*Eurytoma neesii*	Walker	Germany		
Eurytomidae	*Eurytoma nobbei*	Mayr	Germany		2001
Eurytomidae	*Eurytoma nodulosa*	Ratzeburg	Germany		2001
Eurytomidae	*Eurytoma obscura*	Boheman	Germany		
Eurytomidae	*Eurytoma onobrychidis*	Nikol'skaya	Germany		
Eurytomidae	*Eurytoma oophaga*	Silvestri	Germany		
Eurytomidae	*Eurytoma pediaspisi*	Pujade i Villar	Germany		2006
Eurytomidae	*Eurytoma petiolata*	Förster	Germany		2001
Eurytomidae	*Eurytoma phalaridis*	Graham	Germany		2001
Eurytomidae	*Eurytoma pinetorum*	Ratzeburg	Germany		
Eurytomidae	*Eurytoma pistaciae*	Rondani	Germany		2001
Eurytomidae	*Eurytoma pollux*	Claridge	Germany		2001
Eurytomidae	*Eurytoma pumila*	Förster	Germany		2001

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Eurytomidae	*Eurytoma punctulata*	Förster	Germany		2001
Eurytomidae	*Eurytoma robusta*	Mayr	Germany		
Eurytomidae	*Eurytoma rosae*	Nees	Germany		
Eurytomidae	*Eurytoma roseni*	Claridge	Germany		
Eurytomidae	*Eurytoma rufa*	Zerova	Germany		2001
Eurytomidae	*Eurytoma rufipes*	Walker	Germany		2006
Eurytomidae	*Eurytoma scabra*	Förster	Germany		2001
Eurytomidae	*Eurytoma serratulae*	(Fabricius)	Germany		
Eurytomidae	*Eurytoma setigera*	Mayr	Germany		
Eurytomidae	*Eurytoma sphegum*	(Fabricius)	Germany		2001
Eurytomidae	*Eurytoma strigifrons*	Thomson	Germany		
Eurytomidae	*Eurytoma striolata*	Ratzeburg	Germany		2001
Eurytomidae	*Eurytoma truncatella*	Zerova	Germany		
Eurytomidae	*Eurytoma verticillata*	(Fabricius)	Germany		
Eurytomidae	*Eurytoma wachtli*	Mayr	Germany		
Eurytomidae	*Mangoma salicis*	(Walker)	Germany		2001
Eurytomidae	*Sycophila biguttata*	(Swederus)	Germany		
Eurytomidae	*Sycophila concinna*	(Boheman)	Germany		2006
Eurytomidae	*Sycophila fasciata*	(Thomson)	Germany		
Eurytomidae	*Sycophila flavicollis*	(Walker)	Germany		
Eurytomidae	*Sycophila mellea*	(Curtis)	Germany		
Eurytomidae	*Sycophila submutica*	(Thomson)	Germany		
Eurytomidae	*Systole albipennis*	Walker	Germany		2001
Eurytomidae	*Systole atratula*	(Dalla Torre)	Germany		2001
Eurytomidae	*Tetramesa aciculata*	(Schlechtendal)	Germany		
Eurytomidae	*Tetramesa affinis*	(Hedicke)	Germany		
Eurytomidae	*Tetramesa agrostidis*	(Howard)	Germany		2001
Eurytomidae	*Tetramesa airae*	(Schlechtendal)	Germany		
Eurytomidae	*Tetramesa albomaculatum*	(Ashmead)	Germany		2001
Eurytomidae	*Tetramesa brachypodii*	(Schlechtendal)	Germany		2001
Eurytomidae	*Tetramesa brevicollis*	(Walker)	Germany		
Eurytomidae	*Tetramesa brevicornis*	(Walker)	Germany		
Eurytomidae	*Tetramesa brischkei*	(Schlechtendal)	Germany		2001
Eurytomidae	*Tetramesa calamagrostidis*	(Schlechtendal)	Germany		
Eurytomidae	*Tetramesa cylindrica*	(Schlechtendal)	Germany		2001
Eurytomidae	*Tetramesa eximia*	(Giraud)	Germany		
Eurytomidae	*Tetramesa flavipes*	(Förster)	Germany		2001
Eurytomidae	*Tetramesa foersteri*	(Hedicke)	Germany		2001
Eurytomidae	*Tetramesa fulvicollis*	(Walker)	Germany		2001
Eurytomidae	*Tetramesa fumipennis*	(Walker)	Germany		2001
Eurytomidae	*Tetramesa giraudi*	(Schlechtendal)	Germany		2001

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Eurytomidae	*Tetramesa hordei*	(Harris)	Germany		2001
Eurytomidae	*Tetramesa hyalipennis*	(Walker)	Germany		2001
Eurytomidae	*Tetramesa laevigata*	(Hedicke)	Germany		2001
Eurytomidae	*Tetramesa linearis*	(Walker)	Germany		
Eurytomidae	*Tetramesa longicornis*	(Walker)	Germany		2001
Eurytomidae	*Tetramesa longula*	(Dalman)	Germany		
Eurytomidae	*Tetramesa maritima*	(Hedicke)	Germany		
Eurytomidae	*Tetramesa novalis*	Zerova	Germany		2001
Eurytomidae	*Tetramesa petiolata*	(Walker)	Germany		2001
Eurytomidae	*Tetramesa phleicola*	(Hedicke)	Germany		
Eurytomidae	*Tetramesa phragmitis*	(Erdös)	Germany		2001
Eurytomidae	*Tetramesa poae*	(Schlechtendal)	Germany		2001
Eurytomidae	*Tetramesa puccinellae*	Zerova	Germany		2001
Eurytomidae	*Tetramesa scheppigi*	(Schlechtendal)	Germany		2001
Eurytomidae	*Tetramesa schlechtendali*	(Hedicke)	Germany		1921
Eurytomidae	*Tetramesa schmidti*	(Hedicke)	Germany		
Leucospidae	*Leucospis dorsigera*	Fabricius	Germany	1959	
Leucospidae	*Leucospis gigas*	Fabricius	Germany	1959	
Leucospidae	*Leucospis intermedia*	Illiger	Germany	1959	
Mymaridae	*Alaptus auranti*	(Mercet)	Germany		
Mymaridae	*Alaptus extremus*	Soyka	Germany		
Mymaridae	*Alaptus fusculus*	Walker	Germany		2001
Mymaridae	*Alaptus minimus*	Westwood	Germany		
Mymaridae	*Alaptus novickyi*	Soyka	Germany		2001
Mymaridae	*Alaptus pallidornis*	Förster	Germany	2016	
Mymaridae	*Alaptus schmitzi*	Soyka	Germany		2001
Mymaridae	*Alaptus stammeri*	Soyka	Germany		2001
Mymaridae	*Anagrus atomus*	(Linnaeus)	Germany	2009	
Mymaridae	*Anagrus avalae*	Soyka	Germany	2009	
Mymaridae	*Anagrus bakkendorfi*	Soyka	Germany	2009	
Mymaridae	*Anagrus ensifer*	Debauche	Germany	2009	
Mymaridae	*Anagrus foersteri*	(Ratzeburg)	Germany	2009	2001
Mymaridae	*Anagrus incarnatosimilis*	Soyka	Germany	2009	2001
Mymaridae	*Anagrus incarnatus*	Haliday	Germany	2009	
Mymaridae	*Anagrus nigriceps*	(Smits van Burgst)	Germany	2009	
Mymaridae	*Anagrus subfuscus*	Förster	Germany	2009	
Mymaridae	*Anaphes aries*	Debauche	Germany		
Mymaridae	*Anaphes brachygaster*	(Debauche)	Germany		
Mymaridae	*Anaphes brevitarsis*	(Soyka)	Germany		2001
Mymaridae	*Anaphes compressus*	(Soyka)	Germany		2001
Mymaridae	*Anaphes depressus*	(Soyka)	Germany		2001

family	species	author	distribution	revision (year)	single record (year)
Mymaridae	*Anaphes diana*	(Girault)	Germany		
Mymaridae	*Anaphes discolorisimilis*	(Soyka)	Germany		2001
Mymaridae	*Anaphes dorcas*	(Debauche)	Germany		
Mymaridae	*Anaphes exiguus*	(Soyka)	Germany		2001
Mymaridae	*Anaphes flavipes*	(Förster)	Germany		
Mymaridae	*Anaphes flavus*	(Soyka)	Germany		2001
Mymaridae	*Anaphes fuscipennis*	Haliday	Germany		
Mymaridae	*Anaphes gauthieri*	Debauche	Germany		
Mymaridae	*Anaphes germaniacus*	Özdikmen	Germany		
Mymaridae	*Anaphes gracillimus*	(Soyka)	Germany		2001
Mymaridae	*Anaphes intermedius*	(Soyka)	Germany		2001
Mymaridae	*Anaphes leptoceras*	(Debauche)	Germany		2001
Mymaridae	*Anaphes longicornis*	Walker	Germany		1999
Mymaridae	*Anaphes luna*	(Girault)	Germany		1973
Mymaridae	*Anaphes malchinensis*	(Soyka)	Germany		2001
Mymaridae	*Anaphes medius*	Soyka	Germany		2001
Mymaridae	*Anaphes neospecialis*	(Soyka)	Germany		2001
Mymaridae	*Anaphes ovipositor*	Soyka	Germany		2001
Mymaridae	*Anaphes pannonicus*	(Soyka)	Germany		2001
Mymaridae	*Anaphes parallelipennis*	(Soyka)	Germany		2001
Mymaridae	*Anaphes parvus*	(Förster)	Germany		2001
Mymaridae	*Anaphes pilicornis*	(Soyka)	Germany		2001
Mymaridae	*Anaphes quadraticornis*	(Soyka)	Germany		2001
Mymaridae	*Anaphes rectipennis*	(Soyka)	Germany		2001
Mymaridae	*Anaphes regulus*	Walker	Germany		
Mymaridae	*Anaphes serenus*	(Soyka)	Germany		2001
Mymaridae	*Anaphes silesicus*	(Soyka)	Germany		
Mymaridae	*Anaphes sulphuripes*	(Soyka)	Germany		2001
Mymaridae	*Anaphes variatus*	(Soyka)	Germany		2001
Mymaridae	*Anaphes wertaneki*	(Soyka)	Germany		2001
Mymaridae	*Arescon dimidiatus*	(Curtis)	Germany	2003	
Mymaridae	*Camptoptera cardui*	(Förster)	Germany	2014	
Mymaridae	*Camptoptera magna*	Soyka	Germany	2014	2014
Mymaridae	*Camptoptera papaveris*	Förster	Germany	2014	
Mymaridae	*Camptoptera punctum*	(Shaw)	Germany	2014	
Mymaridae	*Caraphractus cinctus*	Walker	Germany	2011	2011
Mymaridae	*Cleruchus janetscheki*	Novicky	Germany	2014	2001
Mymaridae	*Cleruchus pluteus*	Enock	Germany	2014	
Mymaridae	*Cosmocomoidea atra*	(Förster)	Germany		
Mymaridae	*Cosmocomoidea oxypygus*	(Förster)	Germany	2012	
Mymaridae	*Erythmelus agilis*	(Enock)	Germany	2003	2003

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family	species	author	distribution	revision (year)	single record (year)
Mymaridae	*Erythmelus flavovarius*	(Walker)	Germany	2003	
Mymaridae	*Erythmelus panis*	(Enock)	Germany	2003	
Mymaridae	*Eustochus atripennis*	(Curtis)	Germany	2007	
Mymaridae	*Gonatocerus fuscicornis*	(Walker)	Germany	2013	
Mymaridae	*Gonatocerus longicornis*	Nees	Germany	2013	
Mymaridae	*Gonatocerus minimus*	Förster	Germany	2013	2001
Mymaridae	*Gonatocerus pictus*	(Haliday)	Germany		1881
Mymaridae	*Litus cynipseus*	Haliday	Germany	2004	
Mymaridae	*Lymaenon litoralis*	(Haliday)	Germany		
Mymaridae	*Lymaenon longior*	(Soyka)	Germany		
Mymaridae	*Lymaenon novickyi*	(Soyka)	Germany		
Mymaridae	*Mymar pulchellum*	Curtis	Germany	1996	
Mymaridae	*Ooctonus hemipterus*	Haliday	Germany	2010	
Mymaridae	*Ooctonus insignis*	Haliday	Germany	2010	
Mymaridae	*Ooctonus notatus*	Walker	Germany	2010	
Mymaridae	*Ooctonus sublaevis*	Förster	Germany	2010	
Mymaridae	*Ooctonus vulgatus*	Haliday	Germany	2010	
Mymaridae	*Polynema capillatum*	Soyka	Germany		2001
Mymaridae	*Polynema crassicorne*	Förster	Germany		2001
Mymaridae	*Polynema euchariforme*	Haliday	Germany		1978
Mymaridae	*Polynema flavipes*	Walker	Germany	2006	2001
Mymaridae	*Polynema foersteri*	Soyka	Germany		
Mymaridae	*Polynema fumipenne*	Walker	Germany		
Mymaridae	*Polynema fuscipes*	Haliday	Germany		
Mymaridae	*Polynema gracile*	(Nees)	Germany		
Mymaridae	*Polynema gracilior*	Soyka	Germany		2001
Mymaridae	*Polynema laetum*	Förster	Germany		
Mymaridae	*Polynema latipenne*	Förster	Germany		2001
Mymaridae	*Polynema malkwitzi*	Soyka	Germany		2001
Mymaridae	*Polynema marginatum*	(Soyka)	Germany		
Mymaridae	*Polynema neustadti*	Soyka	Germany		2001
Mymaridae	*Polynema novickyi*	Soyka	Germany		2001
Mymaridae	*Polynema ovatum*	Soyka	Germany		
Mymaridae	*Polynema ovulorum*	(Linnaeus)	Germany		
Mymaridae	*Polynema pusillum*	Haliday	Germany		
Mymaridae	*Polynema sachtlebeni*	Soyka	Germany		2001
Mymaridae	*Polynema schmitzi*	Soyka	Germany		
Mymaridae	*Polynema spectabile*	(Soyka)	Germany		
Mymaridae	*Polynema stammeri*	Soyka	Germany		1946
Mymaridae	*Polynema vitripenne*	(Förster)	Germany	2006	2001
Mymaridae	*Stephanodes similis*	(Förster)	Germany	1997	

family	species	author	distribution	revision (year)	single record (year)
Mymaridae	*Stethynium triclavatum*	Enock	Germany		
Ormyridae	*Ormyrus caeruleus*	Walker	Germany		2001
Ormyridae	*Ormyrus chalybeus*	(Ratzeburg)	Germany		1844
Ormyridae	*Ormyrus cingulatus*	(Förster)	Germany		2001
Ormyridae	*Ormyrus cosmozonus*	Förster	Germany		2001
Ormyridae	*Ormyrus diffinis*	(Fonscolombe)	Germany		
Ormyridae	*Ormyrus gratiosus*	(Förster)	Germany		
Ormyridae	*Ormyrus nitidulus*	(Fabricius)	Germany		
Ormyridae	*Ormyrus orientalis*	Walker	Germany		
Ormyridae	*Ormyrus papaveris*	(Perris)	Germany		
Ormyridae	*Ormyrus pomaceus*	(Geoffroy)	Germany		
Ormyridae	*Ormyrus punctulatus*	(Ratzeburg)	Germany		1860
Ormyridae	*Ormyrus rufimanus*	Mayr	Germany		
Ormyridae	*Ormyrus versicolor*	Förster	Germany		2001
Ormyridae	*Ormyrus violaceus*	Förster	Germany		2001
Perilampidae	*Chrysolampus aeneicornis*	Ratzeburg	Germany	2014	
Perilampidae	*Chrysolampus anguliventris*	Nees	Germany	2014	2001
Perilampidae	*Chrysolampus attenuatus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus brevicornis*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus coeruleovirens*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus dubius*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus ellipticus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus excellens*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus foersteri*	Della Torre	Germany	2014	
Perilampidae	*Chrysolampus fuscimanus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus gibbosus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus gilvipes*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus granulatus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus indubitatus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus interruptus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus laevipetiolatus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus pachymerus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus pallitarsis*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus punctatus*	(Förster)	Germany	2014	
Perilampidae	*Chrysolampus rufitarsis*	(Förster)	Germany	2014	
Perilampidae	*Chrysolampus scapularis*	Ratzeburg	Germany	2014	2001
Perilampidae	*Chrysolampus splendidulus*	(Spinola)	Germany	2014	2014
Perilampidae	*Chrysolampus subcarinatus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus subsessilis*	Nees	Germany	2014	2001
Perilampidae	*Chrysolampus tenuiscapus*	Förster	Germany	2014	2001
Perilampidae	*Chrysolampus thenae*	(Walker)	Germany	2014	2014

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family	species	author	distribution	revision (year)	single record (year)
Perilampidae	*Chrysolampus transversus*	Förster	Germany	2014	2001
Perilampidae	*Chrysomalla roseri*	Förster	Germany	2014	
Perilampidae	*Perilampus aeneus*	(Rossius)	Germany		
Perilampidae	*Perilampus angustus*	Nees	Germany		2001
Perilampidae	*Perilampus auratus*	(Panzer)	Germany		
Perilampidae	*Perilampus aureoviridis*	Walker	Germany		
Perilampidae	*Perilampus chrysonotus*	Förster	Germany		2001
Perilampidae	*Perilampus cristatus*	Förster	Germany		
Perilampidae	*Perilampus cuprinus*	Förster	Germany		
Perilampidae	*Perilampus intermedius*	Bouček	Germany		
Perilampidae	*Perilampus laevifrons*	Dalman	Germany		
Perilampidae	*Perilampus micans*	Dalman	Germany		2001
Perilampidae	*Perilampus minutalis*	Steffan	Germany		1985
Perilampidae	*Perilampus neglectus*	Bouček	Germany		2001
Perilampidae	*Perilampus nitens*	Walker	Germany		
Perilampidae	*Perilampus ruficornis*	(Fabricius)	Germany		
Perilampidae	*Perilampus ruschkai*	Hellén	Germany		1985
Perilampidae	*Perilampus tristis*	Mayr	Germany		
Pteromalidae	*Ablaxia robusta*	Hedqvist	Germany		2001
Pteromalidae	*Acroclisis nigricornis*	Förster	Germany		
Pteromalidae	*Aggelma violacea*	(Zetterstedt)	Germany		
Pteromalidae	*Anisopteromalus calandrae*	(Howard)	Germany		
Pteromalidae	*Anogmus hohenheimensis*	(Ratzeburg)	Germany		
Pteromalidae	*Anogmus hungaricus*	(Erdös)	Germany		
Pteromalidae	*Anogmus piceae*	(Ruschka)	Germany		
Pteromalidae	*Anogmus strobilorum*	(Thomson)	Germany		
Pteromalidae	*Anogmus vala*	(Walker)	Germany		
Pteromalidae	*Apsilocera bramleyi*	Graham	Germany		2001
Pteromalidae	*Arthrolytus discoideus*	(Nees)	Germany		
Pteromalidae	*Arthrolytus maculipennis*	(Walker)	Germany		
Pteromalidae	*Arthrolytus ocellus*	(Walker)	Germany		
Pteromalidae	*Asaphes suspensus*	(Nees)	Germany		
Pteromalidae	*Asaphes vulgaris*	Walker	Germany		
Pteromalidae	*Caenacis capnopterus*	(Ratzeburg)	Germany	1961	2001
Pteromalidae	*Caenacis flavipes*	Masi	Germany		
Pteromalidae	*Caenacis inflexa*	(Ratzeburg)	Germany	1961	
Pteromalidae	*Caenacis lauta*	(Walker)	Germany	1961	
Pteromalidae	*Callitula bicolor*	Spinola	Germany		
Pteromalidae	*Callitula elongata*	(Thomson)	Germany		
Pteromalidae	*Callitula ferrierei*	Bouček	Germany		1966
Pteromalidae	*Callitula pyrrhogaster*	(Walker)	Germany		

family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Capellia cecidomyiae*	(Ratzeburg)	Germany		
Pteromalidae	*Capellia orneus*	(Walker)	Germany		2001
Pteromalidae	*Catolaccus ater*	(Ratzeburg)	Germany		
Pteromalidae	*Cea pulicaris*	Walker	Germany		
Pteromalidae	*Cecidolampa barbotini*	Askew	Germany		
Pteromalidae	*Cecidostiba docimus*	(Walker)	Germany	1961	
Pteromalidae	*Cecidostiba fungosa*	(Geoffroy)	Germany	1961	
Pteromalidae	*Cecidostiba geganius*	(Walker)	Germany	1961	
Pteromalidae	*Cecidostiba semifascia*	(Walker)	Germany	1961	
Pteromalidae	*Cerocephala cornigera*	Westwood	Germany		2001
Pteromalidae	*Cerocephala rufa*	(Walker)	Germany		2001
Pteromalidae	*Cheiropachus quadrum*	(Fabricius)	Germany		
Pteromalidae	*Chlorocytus alticornis*	Graham	Germany		2001
Pteromalidae	*Chlorocytus breviscapus*	Graham	Germany		2001
Pteromalidae	*Chlorocytus diversus*	(Walker)	Germany		
Pteromalidae	*Chlorocytus formosus*	(Walker)	Germany		2001
Pteromalidae	*Chlorocytus harmolitae*	Bouček	Germany		
Pteromalidae	*Chlorocytus inchoatus*	Graham	Germany		2001
Pteromalidae	*Chlorocytus longicauda*	(Thomson)	Germany		
Pteromalidae	*Chlorocytus phalaridis*	Graham	Germany		2001
Pteromalidae	*Chlorocytus polichna*	(Walker)	Germany		
Pteromalidae	*Chlorocytus spicatus*	(Walker)	Germany		
Pteromalidae	*Chlorocytus terminalis*	(Walker)	Germany		
Pteromalidae	*Chlorocytus ultonicus*	Graham	Germany		
Pteromalidae	*Cleonymus apicalis*	Förster	Germany	1972	2001
Pteromalidae	*Cleonymus cyaneus*	Förster	Germany	1972	2001
Pteromalidae	*Cleonymus elongatus*	Förster	Germany	1972	2001
Pteromalidae	*Cleonymus eximius*	Förster	Germany	1972	2001
Pteromalidae	*Cleonymus laticornis*	Walker	Germany	1972	2001
Pteromalidae	*Cleonymus viridinitens*	Förster	Germany	1972	2001
Pteromalidae	*Coelopisthia areolata*	Askew	Germany		
Pteromalidae	*Coelopisthia eurynota*	(Förster)	Germany		2001
Pteromalidae	*Coelopisthia extenta*	(Walker)	Germany		
Pteromalidae	*Collentis suecicus*	(Graham)	Germany		2001
Pteromalidae	*Colotrechnus subcoeruleus*	Thomson	Germany		2001
Pteromalidae	*Conomorium amplum*	(Walker)	Germany		2001
Pteromalidae	*Conomorium patulum*	(Walker)	Germany		
Pteromalidae	*Coruna clavata*	Walker	Germany		
Pteromalidae	*Cratomus megacephalus*	(Fabricius)	Germany		
Pteromalidae	*Cryptoprymna atra*	(Walker)	Germany		
Pteromalidae	*Cyclogastrella simplex*	(Walker)	Germany		

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family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Cyrtogaster clavicornis*	Walker	Germany	1965	
Pteromalidae	*Cyrtogaster vulgaris*	Walker	Germany	1965	
Pteromalidae	*Dibrachoides cionobius*	Graham	Germany		2001
Pteromalidae	*Dibrachoides dynastes*	(Förster)	Germany		
Pteromalidae	*Dibrachys affinis*	Masi	Germany		2005
Pteromalidae	*Dibrachys fuscicornis*	(Walker)	Germany	1987	
Pteromalidae	*Dibrachys lignicola*	Graham	Germany	2011	
Pteromalidae	*Dibrachys microgastri*	(Bouché)	Germany	2011	
Pteromalidae	*Dibrachys verovesparum*	Peters & Baur	Germany	2011	2011
Pteromalidae	*Diglochis crinifrons*	(Förster)	Germany		2001
Pteromalidae	*Diglochis paludicola*	Abraham	Germany		2001
Pteromalidae	*Diglochis sylvicola*	(Walker)	Germany		
Pteromalidae	*Dimachus cingulum*	(Nees)	Germany		
Pteromalidae	*Dinarmus acutus*	(Thomson)	Germany		
Pteromalidae	*Dinotiscus aponius*	(Walker)	Germany	2007	
Pteromalidae	*Dinotiscus avrupanensis*	Doganlar	Germany	2007	2007
Pteromalidae	*Dinotiscus colon*	(Linnaeus)	Germany	2007	
Pteromalidae	*Dinotiscus eupterus*	(Walker)	Germany	2007	2001
Pteromalidae	*Dinotiscus isvicrensis*	Doganlar	Germany	2007	
Pteromalidae	*Dipara petiolata*	Walker	Germany		1999
Pteromalidae	*Dirhicnus clandestinus*	(Förster)	Germany		2001
Pteromalidae	*Dirhicnus ramealis*	(Nees)	Germany		
Pteromalidae	*Endomychobius endomychi*	(Walker)	Germany		
Pteromalidae	*Epicopterus choreiformis*	Westwood	Germany		
Pteromalidae	*Erdoesia tessellata*	Bouček	Germany		
Pteromalidae	*Erdoesina alboannulata*	(Ratzeburg)	Germany		
Pteromalidae	*Eulonchetron torymoides*	(Thomson)	Germany		2001
Pteromalidae	*Eumacepolus einersbergensis*	(Ratzeburg)	Germany		2001
Pteromalidae	*Eumacepolus pulcher*	Graham	Germany		1999
Pteromalidae	*Eumacepolus saxeseni*	Graham	Germany		
Pteromalidae	*Euneura lachni*	(Ashmead)	Germany		2001
Pteromalidae	*Euneura saetosa*	(Delucchi)	Germany		
Pteromalidae	*Euneura sopolis*	(Walker)	Germany		
Pteromalidae	*Eunotus acutus*	Kurdjumov	Germany	1972	
Pteromalidae	*Eunotus areolatus*	(Ratzeburg)	Germany	1972	
Pteromalidae	*Eunotus cretaceus*	Walker	Germany	1972	
Pteromalidae	*Eunotus nigriclavis*	(Förster)	Germany	1972	
Pteromalidae	*Eunotus obscurus*	Masi	Germany	1972	
Pteromalidae	*Eunotus parvulus*	Masi	Germany	1972	
Pteromalidae	*Eurydinota leptomera*	Förster	Germany		
Pteromalidae	*Gastracanthus erythrogaster*	(Dalla Torre)	Germany		2001

family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Gastracanthus pulcherrimus*	Westwood	Germany		
Pteromalidae	*Gastrancistrus acontes*	Walker	Germany		2001
Pteromalidae	*Gastrancistrus amabilis*	(Girault & Dodd)	Germany		1966
Pteromalidae	*Gastrancistrus aphidum*	(Ratzeburg)	Germany		2001
Pteromalidae	*Gastrancistrus ater*	(Nees)	Germany		
Pteromalidae	*Gastrancistrus autumnalis*	(Walker)	Germany		
Pteromalidae	*Gastrancistrus claviger*	Förster	Germany		2001
Pteromalidae	*Gastrancistrus fulvicornis*	(Walker)	Germany		2009
Pteromalidae	*Gastrancistrus fulvicoxis*	Graham	Germany		
Pteromalidae	*Gastrancistrus fuscicornis*	Walker	Germany		
Pteromalidae	*Gastrancistrus glabellus*	(Nees)	Germany		
Pteromalidae	*Gastrancistrus picipes*	(Nees)	Germany		
Pteromalidae	*Gastrancistrus pusztensis*	(Erdös)	Germany		
Pteromalidae	*Gastrancistrus rosularum*	(Ratzeburg)	Germany		2001
Pteromalidae	*Gastrancistrus salicis*	(Nees)	Germany		
Pteromalidae	*Gastrancistrus torymiformis*	(Ratzeburg)	Germany		
Pteromalidae	*Gastrancistrus undulatus*	(Ratzeburg)	Germany		2001
Pteromalidae	*Gastrancistrus xylophagorum*	(Ratzeburg)	Germany		2001
Pteromalidae	*Glyphognathus convexus*	(Delucchi)	Germany		2001
Pteromalidae	*Glyphognathus flammeus*	(Delucchi)	Germany		2001
Pteromalidae	*Glyphognathus laevigatus*	(Delucchi)	Germany		2001
Pteromalidae	*Glyphognathus nitidus*	(Delucchi)	Germany		
Pteromalidae	*Gyrinophagus luteipes*	Ruschka	Germany		
Pteromalidae	*Habritys brevicornis*	(Ratzeburg)	Germany		
Pteromalidae	*Halticoptera aenea*	(Walker)	Germany	2006	
Pteromalidae	*Halticoptera circulus*	(Walker)	Germany	2006	
Pteromalidae	*Halticoptera collaris*	(Walker)	Germany	2006	2006
Pteromalidae	*Halticoptera corrusca*	(Gravenhorst)	Germany	2006	2001
Pteromalidae	*Halticoptera crius*	(Walker)	Germany	2006	2006
Pteromalidae	*Halticoptera dimidiata*	(Förster)	Germany	2006	
Pteromalidae	*Halticoptera elongatula*	Graham	Germany	2006	2001
Pteromalidae	*Halticoptera flavicornis*	(Spinola)	Germany	2006	2001
Pteromalidae	*Halticoptera izzetbaysali*	Doganlar	Germany	2006	2006
Pteromalidae	*Halticoptera laevigata*	Thomson	Germany	2006	
Pteromalidae	*Halticoptera mustela*	(Walker)	Germany	2006	
Pteromalidae	*Halticoptera patellana*	(Dalman)	Germany	2006	
Pteromalidae	*Halticoptera plana*	(Förster)	Germany	2006	
Pteromalidae	*Halticoptera polita*	(Walker)	Germany	2006	
Pteromalidae	*Halticoptera smaragdina*	(Curtis)	Germany	2006	
Pteromalidae	*Halticoptera triannulata*	(Erdös)	Germany	2006	2003
Pteromalidae	*Halticoptera vehbikoci*	Doganlar	Germany	2006	2006

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family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Hemitrichus seniculus*	(Nees)	Germany		
Pteromalidae	*Heydenia pretiosa*	Förster	Germany		
Pteromalidae	*Hobbya stenonota*	(Ratzeburg)	Germany	1961	
Pteromalidae	*Holcaeus calligetus*	(Walker)	Germany		
Pteromalidae	*Holcaeus glabriculus*	(Nees)	Germany		2001
Pteromalidae	*Holcaeus gorgasus*	(Walker)	Germany		2001
Pteromalidae	*Holcaeus siccatorum*	(Ratzeburg)	Germany		2001
Pteromalidae	*Holcaeus stenogaster*	(Walker)	Germany		
Pteromalidae	*Holcaeus stylatus*	Graham	Germany		
Pteromalidae	*Homoporus apharetus*	(Walker)	Germany		
Pteromalidae	*Homoporus arestor*	(Walker)	Germany		2001
Pteromalidae	*Homoporus destructor*	(Say)	Germany		
Pteromalidae	*Homoporus febriculosus*	(Girault)	Germany		2001
Pteromalidae	*Homoporus femoralis*	(Förster)	Germany		2001
Pteromalidae	*Homoporus fulviventris*	(Walker)	Germany		
Pteromalidae	*Homoporus gibbiscuta*	(Thomson)	Germany		
Pteromalidae	*Homoporus luniger*	(Nees)	Germany		
Pteromalidae	*Homoporus nypsius*	(Walker)	Germany		
Pteromalidae	*Homoporus semiluteus*	(Walker)	Germany		
Pteromalidae	*Homoporus subniger*	(Walker)	Germany		
Pteromalidae	*Hyperimerus pusillus*	(Walker)	Germany		
Pteromalidae	*Isocyrtus laetus*	Walker	Germany		2001
Pteromalidae	*Janssoniella ambigua*	Graham	Germany		2001
Pteromalidae	*Janssoniella caudata*	Kerrich	Germany		1969
Pteromalidae	*Lampoterma bianellatum*	Graham	Germany		2001
Pteromalidae	*Lampoterma viride*	(Thomson)	Germany		2001
Pteromalidae	*Lamprotatus brevicornis*	Thomson	Germany		
Pteromalidae	*Lamprotatus claviger*	Thomson	Germany		
Pteromalidae	*Lamprotatus picinervis*	Thomson	Germany		2001
Pteromalidae	*Lamprotatus simillimus*	Delucchi	Germany		2001
Pteromalidae	*Lamprotatus splendens*	Westwood	Germany		
Pteromalidae	*Lamprotatus truncatus*	(Fonscolombe)	Germany		
Pteromalidae	*Lariophagus distinguendus*	(Förster)	Germany		
Pteromalidae	*Lariophagus puncticollis*	(Müller)	Germany		
Pteromalidae	*Lariophagus rufipes*	Hedqvist	Germany		
Pteromalidae	*Lariophagus teutonus*	(Della Torre)	Germany		1881
Pteromalidae	*Leptomeraporus nicaee*	(Walker)	Germany		2001
Pteromalidae	*Macroglenes Boučeki*	(Graham)	Germany	2010	1999
Pteromalidae	*Macroglenes brevicornis*	(Nees)	Germany	2010	2001
Pteromalidae	*Macroglenes chalybeus*	(Haliday)	Germany	2010	
Pteromalidae	*Macroglenes compressus*	(Förster)	Germany	2010	

family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Macroglenes conjungens*	(Graham)	Germany	2010	
Pteromalidae	*Macroglenes gramineus*	(Haliday)	Germany	2010	
Pteromalidae	*Macroglenes penetrans*	(Kirby)	Germany	2010	
Pteromalidae	*Macroglenes varicornis*	(Haliday)	Germany	2010	
Pteromalidae	*Meraporus foveolatus*	(Förster)	Germany		2001
Pteromalidae	*Meraporus glaber*	(Szelényi)	Germany		2001
Pteromalidae	*Meraporus graminicola*	Walker	Germany		
Pteromalidae	*Meraporus modestus*	(Förster)	Germany		2001
Pteromalidae	*Merismus megapterus*	Walker	Germany		
Pteromalidae	*Merismus nitidus*	(Walker)	Germany		
Pteromalidae	*Merismus rufipes*	Walker	Germany		
Pteromalidae	*Merismus splendens*	Graham	Germany		2001
Pteromalidae	*Merismus viridis*	(Delucchi)	Germany		2001
Pteromalidae	*Merisus flagellatus*	Bouček	Germany		
Pteromalidae	*Merisus splendidus*	Walker	Germany		
Pteromalidae	*Mesopolobus aequus*	(Walker)	Germany	2007	2001
Pteromalidae	*Mesopolobus albitarsus*	(Walker)	Germany	2007	2013
Pteromalidae	*Mesopolobus amaenus*	(Walker)	Germany	2007	
Pteromalidae	*Mesopolobus bidentis*	(Ratzeburg)	Germany	2007	2001
Pteromalidae	*Mesopolobus citrinus*	(Ratzeburg)	Germany	2007	
Pteromalidae	*Mesopolobus clavatus*	(Ratzeburg)	Germany	2007	2001
Pteromalidae	*Mesopolobus clavicornis*	(Förster)	Germany	2007	2001
Pteromalidae	*Mesopolobus crassipes*	(Ratzeburg)	Germany	2007	2001
Pteromalidae	*Mesopolobus diffinis*	(Walker)	Germany	2007	2001
Pteromalidae	*Mesopolobus dilutipes*	(Ratzeburg)	Germany	2007	2001
Pteromalidae	*Mesopolobus dubius*	(Walker)	Germany	2007	
Pteromalidae	*Mesopolobus fagi*	Askew & Lampe	Germany	2007	2001
Pteromalidae	*Mesopolobus fasciiventris*	Westwood	Germany	2007	
Pteromalidae	*Mesopolobus fuscipes*	(Walker)	Germany	2007	2001
Pteromalidae	*Mesopolobus gemellus*	Baur & Muller	Germany	2007	2007
Pteromalidae	*Mesopolobus graminum*	(Hardh)	Germany	2007	2001
Pteromalidae	*Mesopolobus incultus*	(Walker)	Germany	2007	
Pteromalidae	*Mesopolobus laticornis*	(Walker)	Germany	2007	2001
Pteromalidae	*Mesopolobus longicollis*	Graham	Germany	2007	2001
Pteromalidae	*Mesopolobus mediterraneus*	(Mayr)	Germany	2007	
Pteromalidae	*Mesopolobus morys*	(Walker)	Germany	2007	
Pteromalidae	*Mesopolobus nobilis*	(Walker)	Germany	2007	
Pteromalidae	*Mesopolobus phragmitis*	(Erdös)	Germany	2007	
Pteromalidae	*Mesopolobus rhabdophagae*	(Graham)	Germany	2007	
Pteromalidae	*Mesopolobus semiclavatus*	(Ratzeburg)	Germany	2007	
Pteromalidae	*Mesopolobus sericeus*	(Forster)	Germany	2007	

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family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Mesopolobus spermotrophus*	Hussey	Germany	2007	1971
Pteromalidae	*Mesopolobus subfumatus*	(Ratzeburg)	Germany	2007	
Pteromalidae	*Mesopolobus tarsatus*	(Nees)	Germany	2007	2001
Pteromalidae	*Mesopolobus teliformis*	(Walker)	Germany	2007	
Pteromalidae	*Mesopolobus tibialis*	(Westwood)	Germany	2007	
Pteromalidae	*Mesopolobus typographi*	(Ruschka)	Germany	2007	
Pteromalidae	*Mesopolobus verditer*	(Norton)	Germany	2007	
Pteromalidae	*Mesopolobus xanthocerus*	(Thomson)	Germany	2007	
Pteromalidae	*Metacolus azurescens*	(Ratzeburg)	Germany		2001
Pteromalidae	*Metacolus azureus*	(Ratzeburg)	Germany		
Pteromalidae	*Metacolus unifasciatus*	Förster	Germany		
Pteromalidae	*Metastenus concinnus*	Walker	Germany		
Pteromalidae	*Miscogaster discedens*	(Otten)	Germany		2001
Pteromalidae	*Miscogaster elegans*	Walker	Germany		
Pteromalidae	*Miscogaster maculata*	Walker	Germany		
Pteromalidae	*Miscogaster necopina*	Delucchi	Germany		1978
Pteromalidae	*Miscogaster rufipes*	Walker	Germany		
Pteromalidae	*Mokrzeckia pini*	(Hartig)	Germany		
Pteromalidae	*Muscidifurax raptor*	Girault & Sanders	Germany	1970	
Pteromalidae	*Nasonia vitripennis*	(Walker)	Germany		
Pteromalidae	*Neocatolaccus proximus*	(Förster)	Germany		2001
Pteromalidae	*Nodisoplata diffinis*	(Walker)	Germany		2001
Pteromalidae	*Norbanus obscurus*	(Masi)	Germany	2010	
Pteromalidae	*Norbanus scabriculus*	(Nees)	Germany	2010	
Pteromalidae	*Notanisus sexramosus*	(Erdös)	Germany	2015	2001
Pteromalidae	*Ormocerus latus*	Walker	Germany		2001
Pteromalidae	*Ormocerus vernalis*	Walker	Germany		
Pteromalidae	*Oxysychus pilosulus*	(Thomson)	Germany		2001
Pteromalidae	*Pachycrepoideus vindemmiae*	(Rondani)	Germany		2001
Pteromalidae	*Pachyneuron aphidis*	(Bouché)	Germany		
Pteromalidae	*Pachyneuron coccorum*	(Linnaeus)	Germany		
Pteromalidae	*Pachyneuron flavipes*	(Förster)	Germany		2001
Pteromalidae	*Pachyneuron formosum*	Walker	Germany		
Pteromalidae	*Pachyneuron gibbiscuta*	Thomson	Germany		
Pteromalidae	*Pachyneuron grande*	Thomson	Germany		
Pteromalidae	*Pachyneuron groenlandicum*	(Holmgren)	Germany		
Pteromalidae	*Pachyneuron innoxius*	(Förster)	Germany		2001
Pteromalidae	*Pachyneuron leucopiscida*	Mani	Germany		
Pteromalidae	*Pachyneuron muscarum*	(Linnaeus)	Germany		
Pteromalidae	*Pachyneuron piceae*	(Ratzeburg)	Germany		2001
Pteromalidae	*Pachyneuron ratzeburgi*	Özdikmen	Germany		1884

family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Pachyneuron solitarium*	(Hartig)	Germany		
Pteromalidae	*Pachyneuron vitodurense*	Delucchi	Germany		
Pteromalidae	*Pandelus flavipes*	(Förster)	Germany		
Pteromalidae	*Panstenon oxylus*	(Walker)	Germany		
Pteromalidae	*Pegopus inornatus*	(Walker)	Germany		
Pteromalidae	*Peridesmia congrua*	(Walker)	Germany		
Pteromalidae	*Peridesmia discus*	(Walker)	Germany		1966
Pteromalidae	*Perniphora robusta*	Ruschka	Germany		
Pteromalidae	*Phaenocytus glechomae*	(Förster)	Germany		
Pteromalidae	*Platygerrhus affinis*	(Walker)	Germany	1961	
Pteromalidae	*Plutothrix bicolorata*	(Spinola)	Germany		
Pteromalidae	*Plutothrix coelius*	(Walker)	Germany		
Pteromalidae	*Plutothrix trifasciata*	(Thomson)	Germany		
Pteromalidae	*Polycystus oscinidis*	Kurdjumov	Germany		1958
Pteromalidae	*Pseudocatolaccus nitescens*	(Walker)	Germany		
Pteromalidae	*Psilocera obscura*	Walker	Germany	1992	
Pteromalidae	*Psilocera punctifrons*	(Thomson)	Germany	1992	
Pteromalidae	*Psilocera verticillata*	(Förster)	Germany	1992	2001
Pteromalidae	*Psilonotus achaeus*	Walker	Germany		
Pteromalidae	*Psilonotus adamas*	Walker	Germany		
Pteromalidae	*Psilonotus hortensia*	Walker	Germany		
Pteromalidae	*Psychophagus omnivorus*	(Walker)	Germany		
Pteromalidae	*Pteromalus aberrans*	Förster	Germany		2001
Pteromalidae	*Pteromalus abieticola*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus acicularis*	Förster	Germany		2001
Pteromalidae	*Pteromalus acuminatus*	Förster	Germany		2001
Pteromalidae	*Pteromalus aequus*	Förster	Germany		2001
Pteromalidae	*Pteromalus aerosus*	Förster	Germany		2001
Pteromalidae	*Pteromalus agilis*	Förster	Germany		2001
Pteromalidae	*Pteromalus albescens*	Ratzeburg	Germany		
Pteromalidae	*Pteromalus albipennis*	Walker	Germany		
Pteromalidae	*Pteromalus alternans*	Förster	Germany		2001
Pteromalidae	*Pteromalus ambiguus*	Förster	Germany		2001
Pteromalidae	*Pteromalus angustus*	Förster	Germany		2001
Pteromalidae	*Pteromalus anomalipennis*	Förster	Germany		2001
Pteromalidae	*Pteromalus apicalis*	Nees	Germany		2001
Pteromalidae	*Pteromalus arborivagus*	Förster	Germany		2001
Pteromalidae	*Pteromalus atramentarius*	Förster	Germany		2001
Pteromalidae	*Pteromalus aurantiacus*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus aureolus*	(Thomson)	Germany		
Pteromalidae	*Pteromalus aurifacies*	Förster	Germany		2001

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family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Pteromalus aurinitens*	Förster	Germany		2001
Pteromalidae	*Pteromalus barycerus*	Förster	Germany		2001
Pteromalidae	*Pteromalus bedeguaris*	(Thomson)	Germany		
Pteromalidae	*Pteromalus berylli*	Walker	Germany		2001
Pteromalidae	*Pteromalus bifoveolatus*	Förster	Germany		1966
Pteromalidae	*Pteromalus blandus*	Förster	Germany		2001
Pteromalidae	*Pteromalus breviscapus*	Förster	Germany		2001
Pteromalidae	*Pteromalus brunnicans*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus cardui*	(Erdös)	Germany		
Pteromalidae	*Pteromalus carinatus*	Förster	Germany		2001
Pteromalidae	*Pteromalus caudiger*	(Graham)	Germany		
Pteromalidae	*Pteromalus cerinopus*	Förster	Germany		2001
Pteromalidae	*Pteromalus chalcophanes*	Förster	Germany		1841
Pteromalidae	*Pteromalus chalybaeus*	Nees	Germany		1834
Pteromalidae	*Pteromalus chlorospilus*	(Walker)	Germany		
Pteromalidae	*Pteromalus chrysis*	Förster	Germany		2001
Pteromalidae	*Pteromalus chrysos*	Walker	Germany		
Pteromalidae	*Pteromalus cioni*	(Thomson)	Germany		
Pteromalidae	*Pteromalus cionobius*	(Erdös)	Germany		2001
Pteromalidae	*Pteromalus clavipes*	Förster	Germany		2001
Pteromalidae	*Pteromalus coerulescens*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus coeruleus*	Förster	Germany		2001
Pteromalidae	*Pteromalus colosseus*	Förster	Germany		2001
Pteromalidae	*Pteromalus compactus*	Förster	Germany		2001
Pteromalidae	*Pteromalus compos*	Förster	Germany		2001
Pteromalidae	*Pteromalus concinnus*	Förster	Germany		2001
Pteromalidae	*Pteromalus conformis*	(Graham)	Germany		2001
Pteromalidae	*Pteromalus conoideus*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus conopidarum*	(Bouček)	Germany		
Pteromalidae	*Pteromalus crassus*	Förster	Germany		2001
Pteromalidae	*Pteromalus cryptocephali*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus cubocephalus*	Förster	Germany		2001
Pteromalidae	*Pteromalus cupreus*	Nees	Germany		2001
Pteromalidae	*Pteromalus curculionoides*	(Bouché)	Germany		1834
Pteromalidae	*Pteromalus cylindraceus*	Förster	Germany		2001
Pteromalidae	*Pteromalus cyniphidis*	(Linnaeus)	Germany		
Pteromalidae	*Pteromalus dahlbomi*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus dalmanni*	Förster	Germany		2001
Pteromalidae	*Pteromalus decipiens*	Förster	Germany		2001
Pteromalidae	*Pteromalus depressus*	Förster	Germany		2001
Pteromalidae	*Pteromalus devorator*	Förster	Germany		2001

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Pteromalidae	*Pteromalus diadema*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus diatatus*	Schmidt	Germany		2001
Pteromalidae	*Pteromalus difficilis*	Förster	Germany		2001
Pteromalidae	*Pteromalus dimiduis*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus diminuator*	Förster	Germany		2001
Pteromalidae	*Pteromalus dirutor*	Förster	Germany		1841
Pteromalidae	*Pteromalus dispar*	(Curtis)	Germany		
Pteromalidae	*Pteromalus divitissimus*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus dolichurus*	(Thomson)	Germany		
Pteromalidae	*Pteromalus ecarinatus*	Förster	Germany		2001
Pteromalidae	*Pteromalus egregius*	Förster	Germany		2001
Pteromalidae	*Pteromalus elatus*	Förster	Germany		2001
Pteromalidae	*Pteromalus elevatus*	(Walker)	Germany		
Pteromalidae	*Pteromalus elongatus*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus eminens*	Förster	Germany		2001
Pteromalidae	*Pteromalus esuriens*	Förster	Germany		2001
Pteromalidae	*Pteromalus euurae*	Askew	Germany		
Pteromalidae	*Pteromalus exiguus*	Förster	Germany		2001
Pteromalidae	*Pteromalus exoletus*	Förster	Germany		2001
Pteromalidae	*Pteromalus exsertus*	Förster	Germany		2001
Pteromalidae	*Pteromalus extensus*	Förster	Germany		2001
Pteromalidae	*Pteromalus facilis*	Förster	Germany		2001
Pteromalidae	*Pteromalus fagi*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus fasciatus*	(Thomson)	Germany		
Pteromalidae	*Pteromalus faunigena*	Förster	Germany		2001
Pteromalidae	*Pteromalus ferox*	Förster	Germany		2001
Pteromalidae	*Pteromalus fervidus*	Förster	Germany		2001
Pteromalidae	*Pteromalus festivus*	Förster	Germany		2001
Pteromalidae	*Pteromalus flavipalpis*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus foersteri*	Dalla Torre	Germany		1841
Pteromalidae	*Pteromalus fugax*	Förster	Germany		2001
Pteromalidae	*Pteromalus furtivus*	Förster	Germany		2001
Pteromalidae	*Pteromalus fuscopalpus*	Förster	Germany		2001
Pteromalidae	*Pteromalus genuinus*	Förster	Germany		2001
Pteromalidae	*Pteromalus gnavis*	Förster	Germany		2001
Pteromalidae	*Pteromalus gracillimus*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus gratiosus*	Förster	Germany		1841
Pteromalidae	*Pteromalus guttula*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus habilis*	Förster	Germany		2001
Pteromalidae	*Pteromalus herbaceus*	Förster	Germany		2001
Pteromalidae	*Pteromalus hercyniae*	Ratzeburg	Germany		2001

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family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Pteromalus hieracii*	(Thomson)	Germany		
Pteromalidae	*Pteromalus honestus*	Förster	Germany		2001
Pteromalidae	*Pteromalus hyalopterus*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus hypocyaneus*	Förster	Germany		2001
Pteromalidae	*Pteromalus ignobilis*	Förster	Germany		2001
Pteromalidae	*Pteromalus illustratus*	Förster	Germany		2001
Pteromalidae	*Pteromalus immundus*	Förster	Germany		2001
Pteromalidae	*Pteromalus impressifrons*	Förster	Germany		2001
Pteromalidae	*Pteromalus inanis*	Förster	Germany		2001
Pteromalidae	*Pteromalus incertus*	Förster	Germany		2001
Pteromalidae	*Pteromalus inclytus*	Förster	Germany		2001
Pteromalidae	*Pteromalus inconspicuus*	Förster	Germany		2001
Pteromalidae	*Pteromalus inermis*	Förster	Germany		2001
Pteromalidae	*Pteromalus infelix*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus infestus*	Förster	Germany		2001
Pteromalidae	*Pteromalus infinitus*	Förster	Germany		2001
Pteromalidae	*Pteromalus inquilinus*	Förster	Germany		2001
Pteromalidae	*Pteromalus insignis*	Förster	Germany		1841
Pteromalidae	*Pteromalus intermedius*	(Walker)	Germany		
Pteromalidae	*Pteromalus jejunus*	Förster	Germany		2001
Pteromalidae	*Pteromalus laetus*	Förster	Germany		2001
Pteromalidae	*Pteromalus laevis*	Förster	Germany		
Pteromalidae	*Pteromalus laricinellae*	Ratzeburg	Germany		1848
Pteromalidae	*Pteromalus latreillei*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus lazulinus*	Förster	Germany		2001
Pteromalidae	*Pteromalus lepidotus*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus leptogaster*	Förster	Germany		2001
Pteromalidae	*Pteromalus leptostictus*	Förster	Germany		2001
Pteromalidae	*Pteromalus limbatus*	Förster	Germany		2001
Pteromalidae	*Pteromalus lineolatus*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus lugens*	Förster	Germany		2001
Pteromalidae	*Pteromalus lutulentus*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus macrocerus*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus maculiscapus*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus mandibulatus*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus mariae*	Dalla Torre	Germany		1841
Pteromalidae	*Pteromalus maurus*	Förster	Germany		2001
Pteromalidae	*Pteromalus melancholicus*	Förster	Germany		2001
Pteromalidae	*Pteromalus melanocerus*	Förster	Germany		2001
Pteromalidae	*Pteromalus melanochlorus*	Förster	Germany		2001
Pteromalidae	*Pteromalus microneurus*	Ratzeburg	Germany		1844

family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Pteromalus microps*	(Graham)	Germany		2001
Pteromalidae	*Pteromalus micros*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus mixtus*	Förster	Germany		2001
Pteromalidae	*Pteromalus mobilis*	Förster	Germany		2001
Pteromalidae	*Pteromalus molestus*	Förster	Germany		2001
Pteromalidae	*Pteromalus monochrous*	Förster	Germany		2001
Pteromalidae	*Pteromalus musaeus*	Walker	Germany		2001
Pteromalidae	*Pteromalus nanulus*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus napaeus*	Förster	Germany		2001
Pteromalidae	*Pteromalus naucus*	Förster	Germany		2001
Pteromalidae	*Pteromalus navis*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus nebulosus*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus neesii*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus neglectus*	Förster	Germany		2001
Pteromalidae	*Pteromalus nigricans*	Förster	Germany		2001
Pteromalidae	*Pteromalus nobilis*	Förster	Germany		2001
Pteromalidae	*Pteromalus nodulosus*	Ratzeburg	Germany		1848
Pteromalidae	*Pteromalus nuperus*	Förster	Germany		2001
Pteromalidae	*Pteromalus obductus*	Förster	Germany		2001
Pteromalidae	*Pteromalus obscurus*	Nees	Germany		2001
Pteromalidae	*Pteromalus obvolitans*	Förster	Germany		2001
Pteromalidae	*Pteromalus ochrocerus*	(Thomson)	Germany		
Pteromalidae	*Pteromalus opacus*	Förster	Germany		2001
Pteromalidae	*Pteromalus opimus*	Förster	Germany		2001
Pteromalidae	*Pteromalus ornatus*	Förster	Germany		2001
Pteromalidae	*Pteromalus pachygaster*	Förster	Germany		2001
Pteromalidae	*Pteromalus pachymerus*	Förster	Germany		1841
Pteromalidae	*Pteromalus papaveris*	Förster	Germany		
Pteromalidae	*Pteromalus parietinae*	(Graham)	Germany		
Pteromalidae	*Pteromalus patro*	Walker	Germany		2001
Pteromalidae	*Pteromalus pellucidiventris*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus pellucidus*	Förster	Germany		2001
Pteromalidae	*Pteromalus picinus*	Förster	Germany		2001
Pteromalidae	*Pteromalus pilosellus*	Förster	Germany		2001
Pteromalidae	*Pteromalus planiusculus*	Förster	Germany		2001
Pteromalidae	*Pteromalus platyphilus*	Walker	Germany		2001
Pteromalidae	*Pteromalus platyphilus*	Walker	Germany		2005
Pteromalidae	*Pteromalus pogonochoeri*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus polychlori*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus polycyclus*	Förster	Germany		2001
Pteromalidae	*Pteromalus pomacearum*	Ratzeburg	Germany		2001

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Pteromalidae	*Pteromalus praeceps*	Förster	Germany		2001
Pteromalidae	*Pteromalus praelongus*	Förster	Germany		2001
Pteromalidae	*Pteromalus praepes*	Förster	Germany		2001
Pteromalidae	*Pteromalus praepotens*	Förster	Germany		2001
Pteromalidae	*Pteromalus princeps*	Förster	Germany		2001
Pteromalidae	*Pteromalus propinquus*	Förster	Germany		2001
Pteromalidae	*Pteromalus psyllus*	Förster	Germany		2001
Pteromalidae	*Pteromalus pulcherrimus*	Förster	Germany		2001
Pteromalidae	*Pteromalus pullus*	Förster	Germany		2001
Pteromalidae	*Pteromalus punctum*	Förster	Germany		2001
Pteromalidae	*Pteromalus pungens*	Förster	Germany		2001
Pteromalidae	*Pteromalus puparum*	(Linnaeus)	Germany		
Pteromalidae	*Pteromalus pusillus*	Förster	Germany		2001
Pteromalidae	*Pteromalus pygmaeanae*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus pygmaeus*	Förster	Germany		2001
Pteromalidae	*Pteromalus questionis*	Förster	Germany		2001
Pteromalidae	*Pteromalus racemosi*	Ratzeburg	Germany		1844
Pteromalidae	*Pteromalus ramulorum*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus rapax*	Förster	Germany		2001
Pteromalidae	*Pteromalus ratzeburgii*	Dalla Torre	Germany		1852
Pteromalidae	*Pteromalus regius*	Förster	Germany		2001
Pteromalidae	*Pteromalus relevatus*	Förster	Germany		2001
Pteromalidae	*Pteromalus rhombicus*	Förster	Germany		2001
Pteromalidae	*Pteromalus saltatorius*	Förster	Germany		2001
Pteromalidae	*Pteromalus sapphireus*	Förster	Germany		2001
Pteromalidae	*Pteromalus scandiae*	(Graham)	Germany		1993
Pteromalidae	*Pteromalus semotus*	(Walker)	Germany		
Pteromalidae	*Pteromalus sequester*	Walker	Germany		
Pteromalidae	*Pteromalus similis*	Förster	Germany		2001
Pteromalidae	*Pteromalus simplex*	Förster	Germany		2001
Pteromalidae	*Pteromalus sincerus*	Förster	Germany		2001
Pteromalidae	*Pteromalus singularis*	Förster	Germany		2001
Pteromalidae	*Pteromalus smaragdinus*	Förster	Germany		2001
Pteromalidae	*Pteromalus solidus*	Förster	Germany		2001
Pteromalidae	*Pteromalus sonchi*	Janzon	Germany		2001
Pteromalidae	*Pteromalus sparsus*	Förster	Germany		2001
Pteromalidae	*Pteromalus sphaerogaster*	Förster	Germany		2001
Pteromalidae	*Pteromalus splendidus*	Förster	Germany		2001
Pteromalidae	*Pteromalus strobilobius*	Ratzeburg	Germany		1852
Pteromalidae	*Pteromalus subaequalis*	Förster	Germany		2001
Pteromalidae	*Pteromalus sublaevis*	Förster	Germany		2001

family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Pteromalus subniger*	Förster	Germany		1841
Pteromalidae	*Pteromalus subpunctatus*	Förster	Germany		2001
Pteromalidae	*Pteromalus subterraneus*	Förster	Germany		2001
Pteromalidae	*Pteromalus sulphuripes*	Förster	Germany		2001
Pteromalidae	*Pteromalus sybarita*	Förster	Germany		2001
Pteromalidae	*Pteromalus sylvarum*	Förster	Germany		2001
Pteromalidae	*Pteromalus syntomus*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus terebrans*	Förster	Germany		2001
Pteromalidae	*Pteromalus tessellatus*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus tibialis*	Nees	Germany		2001
Pteromalidae	*Pteromalus timidus*	Dalla Torre	Germany		1852
Pteromalidae	*Pteromalus tricollis*	Förster	Germany		2001
Pteromalidae	*Pteromalus tripolii*	(Graham)	Germany		2001
Pteromalidae	*Pteromalus troglodytes*	Dalla Torre	Germany		1852
Pteromalidae	*Pteromalus unicolor*	Förster	Germany		2001
Pteromalidae	*Pteromalus uyari*	Özdikmen	Germany		2001
Pteromalidae	*Pteromalus vaginatus*	Förster	Germany		2001
Pteromalidae	*Pteromalus vaginulae*	Ratzeburg	Germany		1852
Pteromalidae	*Pteromalus vallatus*	Förster	Germany		2001
Pteromalidae	*Pteromalus vallecula*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus varians*	(Spinola)	Germany		
Pteromalidae	*Pteromalus variolosus*	Förster	Germany		2001
Pteromalidae	*Pteromalus velox*	Förster	Germany		2001
Pteromalidae	*Pteromalus veneris*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus ventricosus*	Förster	Germany		2001
Pteromalidae	*Pteromalus verticalis*	Förster	Germany		2001
Pteromalidae	*Pteromalus vibulenus*	(Walker)	Germany		
Pteromalidae	*Pteromalus vicarius*	Ratzeburg	Germany		2001
Pteromalidae	*Pteromalus vicinus*	Förster	Germany		2001
Pteromalidae	*Pteromalus violarum*	Dalla Torre	Germany		2001
Pteromalidae	*Pteromalus viridicans*	Förster	Germany		2001
Pteromalidae	*Pteromalus vorax*	Förster	Germany		2001
Pteromalidae	*Rakosina deplanata*	Bouček	Germany	1979	
Pteromalidae	*Rhaphitelus ladenbergii*	(Ratzeburg)	Germany		
Pteromalidae	*Rhaphitelus maculatus*	Walker	Germany		
Pteromalidae	*Rhicnocoelia constans*	(Walker)	Germany	1989	
Pteromalidae	*Rhopalicus atricornis*	(Förster)	Germany		2001
Pteromalidae	*Rhopalicus guttatus*	(Ratzeburg)	Germany		
Pteromalidae	*Rhopalicus magdalis*	(Ratzeburg)	Germany		2001
Pteromalidae	*Rhopalicus opisthotomus*	(Ratzeburg)	Germany		2001
Pteromalidae	*Rhopalicus quadratus*	(Ratzeburg)	Germany		

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family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Rhopalicus tutela*	(Walker)	Germany		
Pteromalidae	*Rhopalicus virescens*	(Ratzeburg)	Germany		2001
Pteromalidae	*Roptrocerus mirus*	(Walker)	Germany		
Pteromalidae	*Roptrocerus polychromus*	Förster	Germany		2001
Pteromalidae	*Roptrocerus xylobius*	Förster	Germany		2001
Pteromalidae	*Roptrocerus xylophagorum*	(Ratzeburg)	Germany		
Pteromalidae	*Sceptrothelys deione*	(Walker)	Germany		2001
Pteromalidae	*Sceptrothelys grandiclava*	(Walker)	Germany		
Pteromalidae	*Sceptrothelys intermedia*	Graham	Germany		2001
Pteromalidae	*Sceptrothelys occultus*	(Förster)	Germany		2001
Pteromalidae	*Schimitschekia populi*	Bouček	Germany		
Pteromalidae	*Schizonotus latus*	(Walker)	Germany	1958	
Pteromalidae	*Schizonotus sieboldi*	(Ratzeburg)	Germany	1958	
Pteromalidae	*Scutellista obscura*	(Förster)	Germany		
Pteromalidae	*Seladerma berani*	(Delucchi)	Germany		
Pteromalidae	*Seladerma bicolor*	Walker	Germany		
Pteromalidae	*Seladerma breve*	Walker	Germany		
Pteromalidae	*Seladerma coeruleovirens*	(Förster)	Germany		
Pteromalidae	*Seladerma convexum*	Walker	Germany		2001
Pteromalidae	*Seladerma diffine*	(Walker)	Germany		
Pteromalidae	*Seladerma diutinum*	(Delucchi)	Germany		
Pteromalidae	*Seladerma geniculatum*	(Zetterstedt)	Germany		
Pteromalidae	*Seladerma globosum*	(Delucchi)	Germany		
Pteromalidae	*Seladerma laetum*	Walker	Germany		
Pteromalidae	*Seladerma scaea*	(Walker)	Germany		2001
Pteromalidae	*Seladerma simplex*	(Thomson)	Germany		2001
Pteromalidae	*Semiotellus diversus*	(Walker)	Germany		2001
Pteromalidae	*Semiotellus mundus*	(Walker)	Germany		
Pteromalidae	*Semiotellus punctifrons*	(Nees)	Germany		2001
Pteromalidae	*Semiotellus rujanensis*	Bouček	Germany		2001
Pteromalidae	*Spalangia cameroni*	Perkins	Germany	2009	
Pteromalidae	*Spalangia crassicornis*	Bouček	Germany	2009	
Pteromalidae	*Spalangia endius*	Walker	Germany	2009	
Pteromalidae	*Spalangia erythromera*	Förster	Germany	2009	
Pteromalidae	*Spalangia fuscipes*	Nees	Germany	2009	
Pteromalidae	*Spalangia nigra*	Latreille	Germany	2009	
Pteromalidae	*Spalangia nigripes*	Curtis	Germany	2009	
Pteromalidae	*Spalangia nigroaenea*	Curtis	Germany	2009	
Pteromalidae	*Spalangia rugulosa*	Förster	Germany	2009	
Pteromalidae	*Spalangia subpunctata*	Förster	Germany	2009	
Pteromalidae	*Spalangiopelta alata*	Bouček	Germany		

family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Spaniopus amoenus*	Förster	Germany	1972	
Pteromalidae	*Spaniopus dissimilis*	Walker	Germany	1972	
Pteromalidae	*Spaniopus peisonis*	(Erdös)	Germany	1972	2001
Pteromalidae	*Sphaeripalpus fuscipes*	(Walker)	Germany		2001
Pteromalidae	*Sphaeripalpus punctulatus*	(Förster)	Germany		2001
Pteromalidae	*Sphaeripalpus sericeus*	(Thomson)	Germany		
Pteromalidae	*Sphaeripalpus viridis*	Förster	Germany		2001
Pteromalidae	*Sphegigaster clavicornis*	(Förster)	Germany		2001
Pteromalidae	*Sphegigaster cuscutae*	Ferrière	Germany		
Pteromalidae	*Sphegigaster intersita*	Graham	Germany		2001
Pteromalidae	*Sphegigaster nigricornis*	(Nees)	Germany		
Pteromalidae	*Sphegigaster pallicornis*	(Spinola)	Germany		
Pteromalidae	*Sphegigaster pedunculiventris*	(Spinola)	Germany		2001
Pteromalidae	*Sphegigaster truncata*	Thomson	Germany		2003
Pteromalidae	*Spintherus dubius*	(Nees)	Germany		
Pteromalidae	*Staurothyreus cruciger*	Graham	Germany		2001
Pteromalidae	*Stenomalina bicolor*	(Förster)	Germany		2001
Pteromalidae	*Stenomalina communis*	(Nees)	Germany		2001
Pteromalidae	*Stenomalina dives*	(Walker)	Germany		1999
Pteromalidae	*Stenomalina epistena*	(Walker)	Germany		2001
Pteromalidae	*Stenomalina fallax*	(Förster)	Germany		2001
Pteromalidae	*Stenomalina favorinus*	(Walker)	Germany		2001
Pteromalidae	*Stenomalina gracilis*	(Walker)	Germany		
Pteromalidae	*Stenomalina iera*	(Walker)	Germany		
Pteromalidae	*Stenomalina illudens*	(Walker)	Germany		2001
Pteromalidae	*Stenomalina laticeps*	(Walker)	Germany		
Pteromalidae	*Stenomalina liparae*	(Giraud)	Germany		
Pteromalidae	*Stenomalina micans*	(Olivier)	Germany		
Pteromalidae	*Stenomalina oxygyne*	(Walker)	Germany		2001
Pteromalidae	*Stenomalina spectabilis*	(Förster)	Germany		1841
Pteromalidae	*Stenoselma nigrum*	Delucchi	Germany		
Pteromalidae	*Stictomischus gibbus*	(Walker)	Germany		
Pteromalidae	*Stictomischus groschkei*	Delucchi	Germany		
Pteromalidae	*Stictomischus longiventris*	Thomson	Germany		
Pteromalidae	*Stictomischus miniatus*	Delucchi	Germany		
Pteromalidae	*Stictomischus nitentis*	Delucchi	Germany		
Pteromalidae	*Stictomischus obscurus*	(Walker)	Germany		
Pteromalidae	*Stictomischus scaposus*	Thomson	Germany		
Pteromalidae	*Stictomischus tumidus*	(Walker)	Germany		
Pteromalidae	*Stinoplus lapsanae*	Graham	Germany	2011	
Pteromalidae	*Syntomopus incisus*	Thomson	Germany		

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family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Syntomopus incurvus*	Walker	Germany		
Pteromalidae	*Syntomopus oviceps*	Thomson	Germany		
Pteromalidae	*Syntomopus thoracicus*	Walker	Germany		
Pteromalidae	*Systasis encyrtoides*	Walker	Germany		
Pteromalidae	*Systasis tenuicornis*	Walker	Germany		2001
Pteromalidae	*Termolampa pinicola*	Bouček	Germany		
Pteromalidae	*Theocolax elegans*	(Westwood)	Germany		
Pteromalidae	*Theocolax formiciformis*	Westwood	Germany		
Pteromalidae	*Thinodytes cyzicus*	(Walker)	Germany		
Pteromalidae	*Tomicobia pityophthori*	(Bouček)	Germany		
Pteromalidae	*Tomicobia seitneri*	(Ruschka)	Germany		
Pteromalidae	*Toxeuma acilius*	(Walker)	Germany		
Pteromalidae	*Toxeuma fuscicorne*	Walker	Germany		
Pteromalidae	*Trichomalopsis acuminata*	(Graham)	Germany		2001
Pteromalidae	*Trichomalopsis caesareus*	(Dalla Torre)	Germany		
Pteromalidae	*Trichomalopsis exigua*	(Walker)	Germany		2001
Pteromalidae	*Trichomalopsis fucicola*	(Walker)	Germany		
Pteromalidae	*Trichomalopsis germanica*	(Graham)	Germany		
Pteromalidae	*Trichomalopsis hemiptera*	(Walker)	Germany		
Pteromalidae	*Trichomalopsis microptera*	(Lindeman)	Germany		
Pteromalidae	*Trichomalopsis peregrina*	(Graham)	Germany		
Pteromalidae	*Trichomalopsis potatoriae*	(Graham)	Germany		
Pteromalidae	*Trichomalopsis punctata*	(Ratzeburg)	Germany		2001
Pteromalidae	*Trichomalopsis tigasis*	(Walker)	Germany		2001
Pteromalidae	*Trichomalus annulatus*	(Förster)	Germany	2007	
Pteromalidae	*Trichomalus apertus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus bracteatus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus campestris*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus cinctus*	(Förster)	Germany	2007	2001
Pteromalidae	*Trichomalus conifer*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus coryphe*	(Walker)	Germany	2007	2001
Pteromalidae	*Trichomalus cristatus*	(Förster)	Germany	2007	
Pteromalidae	*Trichomalus elongatus*	Delucchi & Graham	Germany	2007	2001
Pteromalidae	*Trichomalus exquisitus*	(Förster)	Germany	2007	2001
Pteromalidae	*Trichomalus flagellaris*	Graham	Germany	2007	2001
Pteromalidae	*Trichomalus frontalis*	(Thomson)	Germany	2007	
Pteromalidae	*Trichomalus fulgidus*	(Förster)	Germany	2007	
Pteromalidae	*Trichomalus fulvipes*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus generalis*	(Förster)	Germany	2007	2001
Pteromalidae	*Trichomalus germanus*	(Della Torre)	Germany	2007	1841
Pteromalidae	*Trichomalus glabellus*	(Förster)	Germany	2007	2001

family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Trichomalus gynetelus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus helvipes*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus inscitus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus intestinarius*	(Förster)	Germany	2007	2001
Pteromalidae	*Trichomalus lepidus*	(Förster)	Germany	2007	
Pteromalidae	*Trichomalus lonchaeae*	Bouček	Germany	2007	
Pteromalidae	*Trichomalus lucidus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus nanus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus notabilis*	(Förster)	Germany	2007	2001
Pteromalidae	*Trichomalus obsessorius*	(Förster)	Germany	2007	2001
Pteromalidae	*Trichomalus perfectus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus pexatus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus pilosus*	(Ratzeburg)	Germany	2007	2001
Pteromalidae	*Trichomalus posticus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus repandus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus robustus*	(Walker)	Germany	2007	2001
Pteromalidae	*Trichomalus rufinus*	(Walker)	Germany	2007	
Pteromalidae	*Trichomalus rugosus*	Delucchi & Graham	Germany	2007	
Pteromalidae	*Trichomalus statutus*	(Förster)	Germany	2007	
Pteromalidae	*Trichomalus tenellus*	(Walker)	Germany	2007	2001
Pteromalidae	*Tricolas xylocleptis*	Bouček	Germany		
Pteromalidae	*Trigonoderus bimaculatus*	(Nees)	Germany	1993	2001
Pteromalidae	*Trigonoderus cyanescens*	(Förster)	Germany	1993	2001
Pteromalidae	*Trigonoderus filatus*	Walker	Germany	1993	
Pteromalidae	*Trigonoderus immaculatus*	(Nees)	Germany	1993	2001
Pteromalidae	*Trigonoderus occultus*	(Förster)	Germany	1993	2001
Pteromalidae	*Trigonoderus princeps*	Westwood	Germany	1993	
Pteromalidae	*Trigonoderus pulcher*	Walker	Germany	1993	
Pteromalidae	*Tritneptis affinis*	(Nees)	Germany		
Pteromalidae	*Tritneptis diprionis*	Gahan	Germany		2001
Pteromalidae	*Tritneptis klugii*	(Ratzeburg)	Germany		
Pteromalidae	*Urolepis maritima*	(Walker)	Germany		
Pteromalidae	*Urolepis rufipes*	(Ashmead)	Germany		
Pteromalidae	*Vrestovia fidenas*	(Walker)	Germany		2001
Pteromalidae	*Xestomnaster chrysochlorus*	(Walker)	Germany		
Pteromalidae	*Xestomnaster mazares*	(Walker)	Germany		2001
Pteromalidae	*Xiphydriophagus meyerinckii*	(Ratzeburg)	Germany		
Pteromalidae	*Yusufia acerina*	(Bouček)	Germany		
Signiphoridae	*Chartocerus subaeneus*	(Förster)	Germany		
Signiphoridae	*Thysanus ater*	Walker	Germany		
Tanaostigmatidae	*Tanaostigmodes megalarus*	(Walker)	Germany		2005

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family	species	author	distribution	revision (year)	single record (year)
Tetracampidae	*Dipriocampe diprioni*	(Ferrière)	Germany	1958	
Tetracampidae	*Epiclerus nomocerus*	(Masi)	Germany	1958	2001
Tetracampidae	*Epiclerus panyas*	(Walker)	Germany	1958	2001
Tetracampidae	*Epiclerus temenus*	(Walker)	Germany	1958	
Tetracampidae	*Foersterella erdoesi*	Bouček	Germany	2016	
Tetracampidae	*Foersterella reptans*	(Nees)	Germany	2016	
Tetracampidae	*Platynocheilus cuprifrons*	(Nees)	Germany	1958	
Tetracampidae	*Tetracampe impressa*	Förster	Germany	1958	
Torymidae	*Bootanomyia bohemianii*	(Ratzeburg)	Germany		
Torymidae	*Bootanomyia dorsalis*	(Fabricius)	Germany		
Torymidae	*Bootanomyia stigmatizans*	(Fabricius)	Germany		
Torymidae	*Cryptopristus caliginosus*	(Walker)	Germany		
Torymidae	*Eridontomerus laticornis*	(Förster)	Germany	2016	
Torymidae	*Eridontomerus syrphi*	(Förster)	Germany	2016	
Torymidae	*Glyphomerus stigma*	(Fabricius)	Germany		
Torymidae	*Glyphomerus tibialis*	Förster	Germany		2001
Torymidae	*Idiomacromerus papaveris*	(Förster)	Germany	2016	
Torymidae	*Idiomacromerus terebrator*	(Masi)	Germany	2016	1993
Torymidae	*Megastigmus aculeatus*	(Swederus)	Germany	2003	
Torymidae	*Megastigmus atedius*	Walker	Germany	2003	
Torymidae	*Megastigmus bipunctatus*	(Swederus)	Germany	2003	
Torymidae	*Megastigmus brevicaudis*	Ratzeburg	Germany	2003	
Torymidae	*Megastigmus pictus*	(Förster)	Germany	2003	
Torymidae	*Megastigmus pinus*	Parfitt	Germany	2003	
Torymidae	*Megastigmus rosae*	Bouček	Germany	2003	
Torymidae	*Megastigmus spermotrophus*	Wachtl	Germany	2003	
Torymidae	*Megastigmus strobilobius*	Ratzeburg	Germany	2003	
Torymidae	*Megastigmus suspectus*	Borries	Germany	2003	
Torymidae	*Microdontomerus annulatus*	(Spinola)	Germany	2016	
Torymidae	*Monodontomerus aeneus*	(Fonscolombe)	Germany		
Torymidae	*Monodontomerus aereus*	Walker	Germany		
Torymidae	*Monodontomerus dentipes*	(Dalman)	Germany		
Torymidae	*Monodontomerus laricis*	Mayr	Germany		
Torymidae	*Monodontomerus minor*	(Ratzeburg)	Germany		
Torymidae	*Monodontomerus obscurus*	Westwood	Germany		
Torymidae	*Monodontomerus vicicellae*	(Walker)	Germany		
Torymidae	*Podagrion pachymerum*	(Walker)	Germany	2005	1998
Torymidae	*Pseudotorymus arvernicus*	(Walker)	Germany		
Torymidae	*Pseudotorymus leguminus*	Ruschka	Germany		
Torymidae	*Pseudotorymus militaris*	(Boheman)	Germany		
Torymidae	*Pseudotorymus napi*	(Amerling & Kirchner)	Germany		

family	species	author	distribution	revision (year)	single record (year)
Torymidae	*Pseudotorymus papaveris*	(Thomson)	Germany		
Torymidae	*Pseudotorymus salicis*	Ruschka	Germany		
Torymidae	*Pseudotorymus salviae*	Ruschka	Germany		
Torymidae	*Pseudotorymus sapphyrinus*	(Fonscolombe)	Germany		
Torymidae	*Pseudotorymus tarsatus*	(Nees)	Germany		2001
Torymidae	*Torymoides kiesenwetteri*	(Mayr)	Germany		
Torymidae	*Torymus abbreviatus*	Boheman	Germany	1998	
Torymidae	*Torymus affinis*	(Fonscolombe)	Germany	1998	
Torymidae	*Torymus angelicae*	(Walker)	Germany	1998	
Torymidae	*Torymus approximatus*	Förster	Germany	1998	1841
Torymidae	*Torymus argei*	Bouček	Germany	1998	
Torymidae	*Torymus armatus*	Boheman	Germany	1998	
Torymidae	*Torymus arundinis*	(Walker)	Germany	1998	
Torymidae	*Torymus associatus*	Förster	Germany	1998	1841
Torymidae	*Torymus auratus*	(Müller)	Germany	1998	
Torymidae	*Torymus austriacus*	Graham	Germany	1998	
Torymidae	*Torymus azureus*	Boheman	Germany	1998	
Torymidae	*Torymus basalis*	(Walker)	Germany	1998	
Torymidae	*Torymus baudysi*	Bouček	Germany	1998	2001
Torymidae	*Torymus bedeguaris*	(Linnaeus)	Germany	1998	
Torymidae	*Torymus caudatus*	Boheman	Germany	1998	
Torymidae	*Torymus cerri*	(Mayr)	Germany	1998	
Torymidae	*Torymus chloromerus*	(Walker)	Germany	1998	
Torymidae	*Torymus cingulatus*	Nees	Germany	1998	
Torymidae	*Torymus confinis*	(Walker)	Germany	1998	
Torymidae	*Torymus confluens*	Ratzeburg	Germany	1998	1852
Torymidae	*Torymus cultriventris*	Ratzeburg	Germany	1998	
Torymidae	*Torymus cyaneus*	Walker	Germany	1998	
Torymidae	*Torymus difficilis*	Nees	Germany	1998	1834
Torymidae	*Torymus druparum*	Boheman	Germany	1998	
Torymidae	*Torymus eglanteriae*	Mayr	Germany	1998	
Torymidae	*Torymus epilobii*	Graham & Gijswijt	Germany	1998	
Torymidae	*Torymus erucarum*	(Schrank)	Germany	1998	
Torymidae	*Torymus fagi*	(Hoffmeyer)	Germany	1998	2001
Torymidae	*Torymus fagineus*	Graham	Germany	1998	2001
Torymidae	*Torymus fastuosus*	Boheman	Germany	1998	
Torymidae	*Torymus flavipes*	(Walker)	Germany	1998	
Torymidae	*Torymus formosus*	(Walker)	Germany	1998	
Torymidae	*Torymus fuscicornis*	(Walker)	Germany	1998	
Torymidae	*Torymus galii*	Boheman	Germany	1998	
Torymidae	*Torymus geranii*	(Walker)	Germany	1998	

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family	species	author	distribution	revision (year)	single record (year)
Torymidae	*Torymus heyeri*	Wachtl	Germany	1998	
Torymidae	*Torymus igniceps*	Mayr	Germany	1998	2001
Torymidae	*Torymus impar*	Rondani	Germany	1998	
Torymidae	*Torymus kaltenbachi*	Förster	Germany	1998	1840
Torymidae	*Torymus laetus*	(Walker)	Germany	1998	2001
Torymidae	*Torymus longicalcar*	Graham	Germany	1998	
Torymidae	*Torymus microcerus*	(Walker)	Germany	1998	2001
Torymidae	*Torymus microstigma*	(Walker)	Germany	1998	
Torymidae	*Torymus micrurus*	Bouček	Germany	1998	
Torymidae	*Torymus minutus*	Förster	Germany	1998	1840
Torymidae	*Torymus nitidulus*	(Walker)	Germany	1998	2001
Torymidae	*Torymus nobilis*	Boheman	Germany	1998	
Torymidae	*Torymus notatus*	(Walker)	Germany	1998	2013
Torymidae	*Torymus pascuorum*	Bouček	Germany	1998	
Torymidae	*Torymus pastinacae*	Graham & Gijswijt	Germany	1998	
Torymidae	*Torymus persicariae*	Mayr	Germany	1998	
Torymidae	*Torymus phillyreae*	Ruschka	Germany	1998	
Torymidae	*Torymus poae*	(Hoffmeyer)	Germany	1998	
Torymidae	*Torymus quercinus*	Boheman	Germany	1998	
Torymidae	*Torymus resinanae*	Ratzeburg	Germany	1998	1852
Torymidae	*Torymus roboris*	(Walker)	Germany	1998	
Torymidae	*Torymus rosariae*	Graham & Gijswijt	Germany	1998	
Torymidae	*Torymus rubi*	(Schrank)	Germany	1998	
Torymidae	*Torymus ruschkai*	(Hoffmeyer)	Germany	1998	
Torymidae	*Torymus scutellaris*	(Walker)	Germany	1998	
Torymidae	*Torymus speciosus*	Boheman	Germany	1998	1998
Torymidae	*Torymus spinosus*	(Kamijo)	Germany	1998	2010
Torymidae	*Torymus tanaceticola*	Ruschka	Germany	1998	
Torymidae	*Torymus tipulariarum*	Zetterstedt	Germany	1998	
Torymidae	*Torymus varians*	(Walker)	Germany	1998	
Torymidae	*Torymus ventralis*	(Fonscolombe)	Germany	1998	
Trichogrammatidae	*Aphelinoidea bischoffi*	(Novicky)	Germany		2001
Trichogrammatidae	*Asynacta exigua*	(Nees)	Germany		2001
Trichogrammatidae	*Chaetostricha walkeri*	(Förster)	Germany		2001
Trichogrammatidae	*Chaetostrichella pungens*	(Mayr)	Germany		2001
Trichogrammatidae	*Lathromeris danica*	(Kryger)	Germany		1971
Trichogrammatidae	*Lathromeris germanica*	(Girault)	Germany		2001
Trichogrammatidae	*Lathromeris scutellaris*	Förster	Germany		
Trichogrammatidae	*Oligosita foersteri*	Girault	Germany		1914
Trichogrammatidae	*Oligosita subfasciata*	Westwood	Germany		1914
Trichogrammatidae	*Ophioneurus signatus*	Ratzeburg	Germany		

family	species	author	distribution	revision (year)	single record (year)
Trichogrammatidae	*Poropoea stollwerckii*	Förster	Germany		2001
Trichogrammatidae	*Prestwichia aquatica*	Lubbock	Germany		2001
Trichogrammatidae	*Prestwichia solitaria*	Ruschka	Germany		2001
Trichogrammatidae	*Pseudoligosita nigripes*	(Giraud)	Germany	2004	1914
Trichogrammatidae	*Trichogramma brassicae*	Bezdenko	Germany	1982	
Trichogrammatidae	*Trichogramma cacaeciae*	Marchal	Germany		
Trichogrammatidae	*Trichogramma cephalciae*	Hochmut & Martinek	Germany		
Trichogrammatidae	*Trichogramma chilonis*	Ishii	Germany		
Trichogrammatidae	*Trichogramma dendrolimi*	Matsumura	Germany	1984	
Trichogrammatidae	*Trichogramma embryophagum*	(Hartig)	Germany	1997	
Trichogrammatidae	*Trichogramma euproctidis*	(Girault)	Germany		2008
Trichogrammatidae	*Trichogramma evanescens*	Westwood	Germany		
Trichogrammatidae	*Trichogramma minutum*	Riley	Germany		
Trichogrammatidae	*Trichogramma semblidis*	(Aurivillius)	Germany		
Trichogrammatidae	*Trichogramma zeirapherae*	Walter	Germany		
Trichogrammatidae	*Trichogrammatoidea stammeri*	(Novicky)	Germany		2001
Trichogrammatidae	*Ufens foersteri*	(Kryger)	Germany	2011	2011
Aphelinidae	*Aphelinus daucicola*	Kurdjumov	Czech Republic, France		
Aphelinidae	*Aphelinus flaviventris*	Kurdjumov	Czech Republic, France		
Aphelinidae	*Aphelinus humilis*	Mercet	Czech Republic, Netherlands		
Aphelinidae	*Aphelinus subflavescens*	(Westwood)	Czech Republic, Netherlands, France		
Aphelinidae	*Aphytis diaspidis*	(Howard)	Austria, France, Netherlands, Switzerland, Poland		
Aphelinidae	*Aphytis hispanicus*	(Mercet)	France, Czech Republic		
Aphelinidae	*Centrodora livens*	(Walker)	Denmark, Czech Republic, Austria		
Aphelinidae	*Coccophagus silvestrii*	Compere	Czech Republic, France		
Aphelinidae	*Encarsia lutea*	(Masi)	Czech Republic, France		
Aphelinidae	*Protaphelinus nikolskajae*	(Yasnosh)	Denmark, France		
Aphelinidae	*Pteroptrix dimidiata*	Westwood	France, Switzerland, Czech Republic, Poland		
Azotidae	*Ablerus celsus*	(Walker)	Czech Republic, Poland, France		
Chalcididae	*Belaspidia nigra*	(Siebold)	Austria, Belgium, Czech Republic, France, Switzerland		
Chalcididae	*Brachymeria inermis*	(Fonscolombe)	Czech Republic, France, Austria		
Chalcididae	*Dirhinus hesperidum*	(Rossi)	France, Czech Republic, Austria		
Chalcididae	*Hockeria bifasciata*	Walker	Austria, France, Czech Republic		
Chalcididae	*Hockeria unicolor*	Walker	Austria, Czech Republic, France, Netherlands, Poland		
Chalcididae	*Lasiochalcidia dargelasii*	(Latreille)	France, Austria, Czech Republic		
Chalcididae	*Lasiochalcidia guineensis*	(Steffan)	Czech Republic, France		
Chalcididae	*Lasiochalcidia indescripta*	Bouček	Czech Republic, France		
Chalcididae	*Neochalcis fertoni*	(Kieffer)	France, Czech Republic, France		

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Chalcididae	*Neochalcis osmicida*	(Saunders)	Czech Republic, France, Switzerland		
Chalcididae	*Proconura nigripes*	(Fonscolombe)	France, Czech Republic		
Chalcididae	*Psilochalcis subaenea*	(Masi)	Czech Republic, France		
Encyrtidae	*Achalcerinys lindus*	(Mercet)	Czech Republic, France, Netherlands		
Encyrtidae	*Ageniaspis citricola*	Logvinovskaya	France, Poland		
Encyrtidae	*Anagyrus aligarhensis*	Agarwal & Alam	Czech Republic, France		
Encyrtidae	*Anagyrus bohemanni*	(Westwood)	Austria, Czech Republic, France, Netherlands, Poland		
Encyrtidae	*Anagyrus Boučeki*	Hoffer	Czech Republic, Netherlands		
Encyrtidae	*Anthemus funicularis*	(Bakkendorf)	Czech Republic, Denmark		
Encyrtidae	*Anthemus leucaspidis*	Mercet	France, Poland		
Encyrtidae	*Arrhenophagus chionaspidis*	Aurivillius	Czech Republic, France, Poland, Switzerland		
Encyrtidae	*Asitus phragmitis*	(Ferrière)	Czech Republic, France		
Encyrtidae	*Bothriothorax aralius*	(Walker)	Denmark, Netherlands		
Encyrtidae	*Bothriothorax serratellus*	(Dalman)	Czech Republic, Denmark, Netherlands, Switzerland		
Encyrtidae	*Cerchysiella planiscutellum*	(Mercet)	Czech Republic, France, Netherlands		
Encyrtidae	*Cheiloneurus boldyrevi*	Trjapitzin & Agekyan	Czech Republic, France, Netherlands		
Encyrtidae	*Cheiloneurus submuticus*	Thomson	Czech Republic, Denmark		
Encyrtidae	*Comperiella bifasciata*	Howard	Czech Republic, France		
Encyrtidae	*Copidosoma anceus*	(Walker)	Denmark, France, Netherlands, Switzerland		
Encyrtidae	*Copidosoma ancharus*	(Walker)	Czech Republic, France, Netherlands		
Encyrtidae	*Copidosoma arenarium*	Erdös	Czech Republic, France		
Encyrtidae	*Copidosoma bolivari*	Mercet	Czech Republic, France		
Encyrtidae	*Copidosoma charon*	Guerrieri & Noyes	Austria, Czech Republic, France		
Encyrtidae	*Copidosoma cyaneum*	Hoffer	Czech Republic, Denmark, France		
Encyrtidae	*Copidosoma fadus*	(Walker)	Czech Republic, France		
Encyrtidae	*Copidosoma gloriosum*	(Mercet)	Austria, Czech Republic, France		
Encyrtidae	*Copidosoma ratzeburgi*	Mercet	Czech Republic, France		
Encyrtidae	*Copidosoma subalbicorne*	(Hoffer)	Czech Republic, Denmark, Netherlands		
Encyrtidae	*Copidosoma tibiale*	Hoffer	Austria, Czech Republic, France, Netherlands		
Encyrtidae	*Dicarnosis helena*	Hoffer	Austria, Czech Republic, France		
Encyrtidae	*Discodes trjapitzini*	Herthevtzian	Czech Republic, France, Austria		
Encyrtidae	*Ectroma arenarium*	(Erdös)	Denmark, Austria, Czech Republic		
Encyrtidae	*Ginsiana carpetana*	(Mercet)	Czech Republic, Denmark, France, Netherlands, Poland		
Encyrtidae	*Globulencyrtus politus*	(Hoffer)	Czech Republic, France		

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Encyrtidae	*Homalotyloidea erginus*	(Walker)	Czech Republic, France, Netherlands		
Encyrtidae	*Homalotyloidea nowickyi*	Hoffer	Czech Republic, Netherlands		
Encyrtidae	*Hoplopsis minuta*	(Fabricius)	Czech Republic, France, Netherlands		
Encyrtidae	*Isodromus flaviscutum*	Hoffer & Trjapitzin	Czech Republic, France		
Encyrtidae	*Lyka submetallica*	Mercet	Czech Republic, France		
Encyrtidae	*Metaphycus ater*	(Mercet)	Austria, Czech Republic, Denmark, France		
Encyrtidae	*Metaphycus dispar*	(Mercet)	Czech Republic, France		
Encyrtidae	*Metaphycus flavovarius*	(Mercet)	Czech Republic, France, Netherlands		
Encyrtidae	*Metaphycus flavus*	(Howard)	France, Czech Republic		
Encyrtidae	*Metaphycus hageni*	Daane & Caltagirone	Denmark, France		
Encyrtidae	*Metaphycus hanstediensis*	Bakkendorf	Czech Republic, Denmark		
Encyrtidae	*Metaphycus nadius*	(Walker)	Poland, Czech Republic, France, Netherlands		
Encyrtidae	*Metaphycus pappus*	(Walker)	Czech Republic, Denmark, Netherlands		
Encyrtidae	*Metaphycus petitus*	(Walker)	Czech Republic, Denmark		
Encyrtidae	*Microterys cedrenus*	(Walker)	France, Denmark		
Encyrtidae	*Microterys jalysus*	(Walker)	Czech Republic, Denmark		
Encyrtidae	*Microterys madyes*	(Walker)	Denmark, Czech Republic		
Encyrtidae	*Microterys matritensis*	(Mercet)	Czech Republic, France		
Encyrtidae	*Microterys subcupratus*	(Dalman)	Czech Republic, Denmark		
Encyrtidae	*Microterys triozae*	(André)	Czech Republic, France		
Encyrtidae	*Mohelniella silhavyi*	Hoffer	Czech Republic, Denmark		
Encyrtidae	*Moraviella inexpectata*	Hoffer	Czech Republic, Denmark		
Encyrtidae	*Ooencyrtus pityocampae*	(Mercet)	France, Poland		
Encyrtidae	*Parasauleia trjapitzini*	Hoffer	Czech Republic, France		
Encyrtidae	*Paratetracnemoidea malenotti*	(Mercet)	Czech Republic, France		
Encyrtidae	*Prochiloneurus bolivari*	Mercet	Austria, Czech Republic, France, Poland		
Encyrtidae	*Pseudococcobius obenbergeri*	(Novickij)	Czech Republic, Denmark		
Encyrtidae	*Psyllaephagus lusitanicus*	(Mercet)	Czech Republic, Netherlands		
Encyrtidae	*Syrphophagus annulipes*	(Thomson)	Czech Republic, Netherlands		
Encyrtidae	*Syrphophagus ariantes*	(Walker)	France, Czech Republic, France		
Encyrtidae	*Syrphophagus quercicola*	(Hoffer)	Czech Republic, Netherlands		
Encyrtidae	*Trechnites alni*	Erdös	Czech Republic, Denmark, Netherlands		
Encyrtidae	*Trechnites flavipes*	(Mercet)	Czech Republic, Denmark, France, Poland		
Encyrtidae	*Xanthoectroma aquilinum*	Mercet	Czech Republic, France		
Eulophidae	*Achrysocharoides butus*	(Walker)	Czech Republic, Netherlands, Poland		
Eulophidae	*Apotetrastichus postmarginalis*	(Bouček)	Czech Republic, France, Austria		

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Eulophidae	*Aprostocetus agrus*	(Walker)	Czech Republic, France, Netherlands		
Eulophidae	*Aprostocetus amenon*	(Walker)	Czech Republic, Netherlands		
Eulophidae	*Aprostocetus apiculatus*	Graham	Czech Republic, France		
Eulophidae	*Aprostocetus arrabonicus*	(Erdös)	Czech Republic, Netherlands		
Eulophidae	*Aprostocetus capitigenae*	Graham	Austria, Netherlands		
Eulophidae	*Aprostocetus celtidis*	(Erdös)	Czech Republic, France, Netherlands		
Eulophidae	*Aprostocetus cerricola*	(Erdös)	Austria, Belgium, Czech Republic, France		
Eulophidae	*Aprostocetus cyniphidum*	(Ratzeburg)	Austria, Netherlands		
Eulophidae	*Aprostocetus dauci*	Graham	Czech Republic, France		
Eulophidae	*Aprostocetus distichus*	Graham	Czech Republic, France		
Eulophidae	*Aprostocetus domenichinii*	(Erdös)	Czech Republic, France		
Eulophidae	*Aprostocetus epilobii*	Graham	Czech Republic, Netherlands		
Eulophidae	*Aprostocetus eurytus*	(Walker)	Czech Republic, France, Netherlands		
Eulophidae	*Aprostocetus fonscolombei*	Graham	Czech Republic, France		
Eulophidae	*Aprostocetus forsteri*	(Walker)	Austria, Czech Republic, France, Switzerland, Austria		
Eulophidae	*Aprostocetus menius*	(Walker)	Czech Republic, France		
Eulophidae	*Aprostocetus oreophilus*	(Förster)	Czech Republic, France, Switzerland		
Eulophidae	*Aprostocetus orestes*	Graham	Czech Republic, France		
Eulophidae	*Aprostocetus planiusculus*	(Thomson)	Czech Republic, Netherlands		
Eulophidae	*Aprostocetus polygoni*	(Erdös)	Czech Republic, Netherlands		
Eulophidae	*Aprostocetus rhipheus*	(Walker)	Czech Republic, Netherlands		
Eulophidae	*Aprostocetus rufus*	(Bakkendorf)	Czech Republic, Denmark, France, Netherlands		
Eulophidae	*Aprostocetus setosulus*	Graham	Czech Republic, France		
Eulophidae	*Aprostocetus subanellatus*	Graham	Czech Republic, France, Netherlands		
Eulophidae	*Aprostocetus suevius*	(Walker)	Czech Republic, Netherlands		
Eulophidae	*Aprostocetus tenuiradialis*	Graham	Czech Republic, France, Netherlands		
Eulophidae	*Aprostocetus tymber*	(Walker)	Czech Republic, Netherlands, France, Poland		
Eulophidae	*Aprostocetus viridescens*	(Förster)	Switzerland, France		
Eulophidae	*Aprostocetus viridinitens*	Graham	Czech Republic, France		
Eulophidae	*Aprostocetus westwoodii*	(Fonscolombe)	Czech Republic, France		
Eulophidae	*Aprostocetus xanthomelas*	Graham	Czech Republic, France		
Eulophidae	*Aulogymnus testaceoviridis*	(Erdös)	Czech Republic, France		
Eulophidae	*Aulogymnus trilineatus*	(Mayr)	Austria, Czech Republic, France, Netherlands, Poland		
Eulophidae	*Baryscapus berhidanus*	Erdös	Czech Republic, France		
Eulophidae	*Baryscapus elasmi*	(Graham)	France, Poland		

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Eulophidae	*Baryscapus fossarum*	Graham	Czech Republic, France, Netherlands		
Eulophidae	*Baryscapus szocsi*	(Erdös)	Czech Republic, France		
Eulophidae	*Chrysocharis albicoxis*	Erdös	Czech Republic, France		
Eulophidae	*Chrysocharis amanus*	(Walker)	Czech Republic, France, Netherlands, Poland		
Eulophidae	*Chrysocharis argyropezae*	Graham	Czech Republic, Netherlands		
Eulophidae	*Chrysocharis collaris*	Graham	Czech Republic, Netherlands		
Eulophidae	*Chrysocharis loranthellae*	Erdös	Czech Republic, France		
Eulophidae	*Chrysocharis paradoxa*	Hansson	Czech Republic, France		
Eulophidae	*Chrysocharis pilicoxa*	(Thomson)	Czech Republic, Netherlands		
Eulophidae	*Elachertus longipetiolus*	Bouček	Czech Republic, France		
Eulophidae	*Elasmus arcuatus*	Ferrière	Czech Republic, France		
Eulophidae	*Elasmus platyedrae*	Ferrière	Austria, France, Czech Republic		
Eulophidae	*Elasmus rufiventris*	Ferrière	Czech Republic, France		
Eulophidae	*Entedon hercyna*	Walker	Czech Republic, Netherlands		
Eulophidae	*Entedon nigrini*	Bouček	Czech Republic, Denmark, France		
Eulophidae	*Entedon pallicrus*	Erdös	Czech Republic, France, Netherlands		
Eulophidae	*Entedon pseudonigritarsis*	Erdös	Czech Republic, Netherlands		
Eulophidae	*Entedon sparetus*	Walker	Czech Republic, France		
Eulophidae	*Entedon squamosus*	Thomson	Czech Republic, Netherlands		
Eulophidae	*Hemiptarsenus autonomus*	(Mercet)	Austria, Czech Republic, France		
Eulophidae	*Hemiptarsenus zilahisebessi*	Erdös	Czech Republic, France, Poland		
Eulophidae	*Ionympha ochus*	(Walker)	Czech Republic, Netherlands		
Eulophidae	*Microlycus virens*	Erdös	Czech Republic, France		
Eulophidae	*Neochrysocharis arvensis*	Graham	Czech Republic, Denmark		
Eulophidae	*Neotrichoporoides cavigena*	Graham	Czech Republic, France		
Eulophidae	*Neotrichoporoides gordensis*	Graham	Czech Republic, France		
Eulophidae	*Neotrichoporoides mediterraneus*	Graham	Czech Republic, France		
Eulophidae	*Neotrichoporoides viridimaculatus*	(Fullaway)	Czech Republic, France		
Eulophidae	*Omphale admirabilis*	(Westwood)	Austria, Czech Republic, France, Netherlands		
Eulophidae	*Omphale coilus*	(Walker)	Czech Republic, Netherlands, Poland		
Eulophidae	*Omphale cornula*	Hansson & Shevtsova	Denmark, France, Netherlands		
Eulophidae	*Omphale euphorbiae*	Hansson & Shevtsova	Czech Republic, France, Netherlands		
Eulophidae	*Omphale isander*	(Walker)	Austria, Czech Republic, France		
Eulophidae	*Omphale parma*	Hansson & Shevtsova	Denmark, France		
Eulophidae	*Oomyzus anomalus*	Graham	Czech Republic, France		
Eulophidae	*Pediobius deplanatus*	Bouček	Czech Republic, Netherlands		
Eulophidae	*Pnigalio hirtulus*	(Erdös)	Czech Republic, France		

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Eulophidae	*Pnigalio mediterraneus*	Ferrière & Delucchi	France, Austria		
Eulophidae	*Pronotalia hungarica*	(Erdös)	Czech Republic, France		
Eulophidae	*Quadrastichus anysis*	(Walker)	Czech Republic, France		
Eulophidae	*Quadrastichus citrinus*	(Thomson)	Czech Republic, France, Austria		
Eulophidae	*Quadrastichus lasiocerus*	(Graham)	Czech Republic, France, Netherlands		
Eulophidae	*Quadrastichus pteridis*	Graham	Austria, Netherlands		
Eulophidae	*Quadrastichus thysanotus*	(Förster)	Czech Republic, Switzerland		
Eulophidae	*Quadrastichus vacuna*	(Walker)	Czech Republic, France, Netherlands, Poland, Switzerland, Austria		
Eulophidae	*Quadrastichus xanthosoma*	(Graham)	Czech Republic, Netherlands		
Eulophidae	*Sympiesis gyorfii*	Erdös	Austria, Czech Republic, France, Poland		
Eulophidae	*Tamarixia leptothrix*	Graham	Czech Republic, Netherlands		
Eulophidae	*Tamarixia tremblayi*	(Domenichini)	Czech Republic, Netherlands		
Eulophidae	*Tetrastichus agrilocidus*	Graham	Czech Republic, Netherlands, Poland		
Eulophidae	*Tetrastichus leocrates*	(Walker)	Denmark, France, Netherlands		
Eulophidae	*Tetrastichus leptosoma*	Graham	Czech Republic, France		
Eulophidae	*Tetrastichus pachycerus*	Graham	Czech Republic, France		
Eulophidae	*Tetrastichus sodalis*	Graham	Czech Republic, France		
Eupelmidae	*Calosota aestivalis*	Curtis	Czech Republic, France, Netherlands, Poland		
Eupelmidae	*Eupelmus falcatus*	(Nikol'skaya)	Czech Republic, France, Switzerland		
Eupelmidae	*Eupelmus muellneri*	Ruschka	France, Czech Republic		
Eupelmidae	*Eupelmus pini*	Taylor	Czech Republic, Netherlands, Austria, France, Poland		
Eupelmidae	*Eupelmus pullus*	Ruschka	Austria, Czech Republic, Netherlands, Poland		
Eupelmidae	*Reikosiella hungarica*	(Erdös)	Czech Republic, France		
Eurytomidae	*Bruchophagus squamea*	(Walker)	France, Czech Republic, France		
Eurytomidae	*Eurytoma gyorfii*	Erdös	Czech Republic, France		
Eurytomidae	*Eurytoma laricis*	Yano	Poland, Netherlands		
Eurytomidae	*Eurytoma stenostigma*	Thomson	Czech Republic, France		
Eurytomidae	*Eurytoma tilicola*	Hedqvist	Czech Republic, France		
Eurytomidae	*Sycophila scorzonerae*	(Mayr)	Austria, Czech Republic, France		
Eurytomidae	*Sycophila variegata*	(Curtis)	France, Czech Republic, Austria, Netherlands, Switzerland		
Eurytomidae	*Systole bipunctata*	Erdös	Czech Republic, France		
Eurytomidae	*Systole hofferi*	(Kalina)	Czech Republic, France		
Leucospidae	*Leucospis biguetina*	Jurine	Austria, Czech Republic, France, Switzerland		
Mymaridae	*Alaptus minimus*	Westwood	Netherlands, Switzerland		
Mymaridae	*Anagrus brocheri*	Schulz	Austria, Belgium, Denmark, Netherlands, Switzerland		

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Mymaridae	*Anaphes declinatus*	(Soyka)	Netherlands, Poland, France		
Mymaridae	*Anaphes pallidus*	(Soyka)	Czech Republic, Netherlands		
Mymaridae	*Camptoptera franciscae*	(Debauche)	Austria, Belgium		
Mymaridae	*Cleruchus taktochno*	Triapitsyn	Belgium, Denmark, Poland		
Mymaridae	*Cosmocomoidea tremulae*	(Bakkendorf)	Denmark, Netherlands		
Mymaridae	*Erythmelus gracilis*	(Howard)	France, Poland		
Mymaridae	*Polynema altitudine*	(Soyka)	Austria, Netherlands		
Mymaridae	*Polynema quadruplex*	(Soyka)	Netherlands, Austria		
Ormyridae	*Ormyrus wachtli*	Mayr	Austria, Czech Republic, France		
Perilampidae	*Perilampus eximius*	Masi	Czech Republic, France		
Pteromalidae	*Ablaxia parviclava*	(Thomson)	Czech Republic, Netherlands, France		
Pteromalidae	*Ablaxia squamifera*	(Thomson)	Belgium, Czech Republic, Netherlands		
Pteromalidae	*Acrocormus semifasciatus*	Thomson	Czech Republic, Netherlands, Poland, Switzerland		
Pteromalidae	*Anogmus laricis*	Bouček	Austria, Netherlands, Poland		
Pteromalidae	*Apelioma pteromalinum*	(Thomson)	Belgium, Czech Republic		
Pteromalidae	*Apsilocera verticillata*	Bouček	Czech Republic, Netherlands		
Pteromalidae	*Arthrolytus slovacus*	Graham	Czech Republic, Netherlands		
Pteromalidae	*Bairamlia fuscipes*	Waterston	Netherlands, Switzerland, France, Czech Republic		
Pteromalidae	*Caenocrepis arenicola*	(Thomson)	Austria, Czech Republic, France		
Pteromalidae	*Chlorocytus pilosus*	Graham	Czech Republic, Netherlands		
Pteromalidae	*Chlorocytus planus*	(Walker)	Netherlands, Czech Republic		
Pteromalidae	*Cleonymus brevis*	Bouček	Czech Republic, France, Switzerland		
Pteromalidae	*Cleonymus obscurus*	Walker	Czech Republic, France		
Pteromalidae	*Cyclogastrella clypealis*	Bouček	Belgium, Czech Republic, France, Switzerland		
Pteromalidae	*Dinotoides tenebricus*	(Walker)	Czech Republic, Belgium, Netherlands		
Pteromalidae	*Ecrizotes filicornis*	(Thomson)	Czech Republic, Netherlands		
Pteromalidae	*Erythromalus nubilipennis*	(Walker)	Austria, Czech Republic, Netherlands		
Pteromalidae	*Erythromalus rufiventris*	(Walker)	Belgium, Czech Republic, Netherlands		
Pteromalidae	*Gastrancistrus acutus*	Walker	Czech Republic, Netherlands		
Pteromalidae	*Gastrancistrus amaboeus*	Walker	Belgium, Czech Republic		
Pteromalidae	*Gastrancistrus clavatus*	(Thomson)	Czech Republic, Netherlands		
Pteromalidae	*Gastrancistrus dispar*	Graham	Czech Republic, Netherlands		
Pteromalidae	*Gastrancistrus hamillus*	Walker	Czech Republic, Netherlands		
Pteromalidae	*Gastrancistrus puncticollis*	(Thomson)	Czech Republic, Netherlands		
Pteromalidae	*Gastrancistrus vagans*	Westwood	Belgium, Czech Republic, France		
Pteromalidae	*Glyphognathus laevis*	(Delucchi)	Czech Republic, Netherlands		

(APPENDIX 1)

family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Gyrinophagus aper*	(Walker)	Austria, Belgium, Czech Republic		
Pteromalidae	*Halticoptera hippeus*	(Walker)	Belgium, Czech Republic		
Pteromalidae	*Heteroprymna longicornis*	(Walker)	Czech Republic, Netherlands		
Pteromalidae	*Holcaeus compressus*	(Walker)	Belgium, Czech Republic, Netherlands		
Pteromalidae	*Holcaeus gracilis*	(Walker)	Czech Republic, Belgium, Netherlands		
Pteromalidae	*Homoporus pulchripes*	Erdös	Czech Republic, France, Switzerland		
Pteromalidae	*Kaleva corynocera*	Graham	Belgium, Czech Republic		
Pteromalidae	*Lamprotatus annularis*	(Walker)	Belgium, Czech Republic, Netherlands		
Pteromalidae	*Lamprotatus crassipes*	Thomson	Czech Republic, Netherlands, Austria		
Pteromalidae	*Lamprotatus novickyi*	(Delucchi)	Netherlands, Austria, Switzerland		
Pteromalidae	*Lonchetron fennicum*	Graham	Czech Republic, France, Poland		
Pteromalidae	*Macroglenes paludum*	(Graham)	Czech Republic, Netherlands, Switzerland		
Pteromalidae	*Macromesus amphiretus*	Walker	Czech Republic, Denmark, France, Poland		
Pteromalidae	*Melancistrus mucronatus*	(Thomson)	Czech Republic, Netherlands		
Pteromalidae	*Mesopolobus aspilus*	(Walker)	Czech Republic, Denmark		
Pteromalidae	*Mesopolobus maculicornis*	(Giraud)	Austria, Czech Republic, France		
Pteromalidae	*Mesopolobus pinus*	Hussey	Denmark, Netherlands, Poland		
Pteromalidae	*Mesopolobus prasinus*	(Walker)	Austria, Netherlands		
Pteromalidae	*Mesopolobus trasullus*	(Walker)	Belgium, France, Czech Republic, Switzerland		
Pteromalidae	*Mesopolobus zetterstedtii*	(Dalla Torre)	Czech Republic, Belgium, Poland		
Pteromalidae	*Micradelus acutus*	Graham	Belgium, Czech Republic, Netherlands		
Pteromalidae	*Micradelus rotundus*	Walker	Czech Republic, Netherlands		
Pteromalidae	*Norbanus calabrus*	(Masi)	Czech Republic, France		
Pteromalidae	*Norbanus cerasiops*	(Masi)	Czech Republic, France		
Pteromalidae	*Norbanus meridionalis*	(Masi)	Czech Republic, France		
Pteromalidae	*Notanisus versicolor*	Walker	Czech Republic, France		
Pteromalidae	*Novitzkyanus cryptogaster*	Bouček	Czech Republic, France		
Pteromalidae	*Panstenon agylla*	(Walker)	Czech Republic, Netherlands		
Pteromalidae	*Pezilepsis dentifera*	(Thomson)	Czech Republic, Belgium		
Pteromalidae	*Platygerrhus dolosus*	(Walker)	Czech Republic, France, Netherlands, Poland		
Pteromalidae	*Platygerrhus ductilis*	(Walker)	Czech Republic, Netherlands, Poland		
Pteromalidae	*Platygerrhus longigena*	Graham	Czech Republic, France, Netherlands		
Pteromalidae	*Platygerrhus millenius*	Szczepanski	Netherlands, Poland		
Pteromalidae	*Platygerrhus unicolor*	Graham	Czech Republic, Netherlands		

family	species	author	distribution	revision (year)	single record (year)
Pteromalidae	*Plutothrix acuminata*	(Thomson)	Belgium, Netherlands, Czech Republic, France		
Pteromalidae	*Psilocera concolor*	(Thomson)	Czech Republic, Netherlands		
Pteromalidae	*Psilocera confusa*	Graham	Czech Republic, France, Netherlands		
Pteromalidae	*Psilocera crassispina*	(Thomson)	Belgium, Czech Republic, France, Netherlands		
Pteromalidae	*Pteromalus altus*	(Walker)	Czech Republic, Belgium, France, Netherlands		
Pteromalidae	*Pteromalus apum*	(Retzius)	Belgium, France, Netherlands, Czech Republic, Denmark, Switzerland		
Pteromalidae	*Pteromalus crassinervis*	(Thomson)	Czech Republic, Belgium, Netherlands		
Pteromalidae	*Pteromalus eudecipiens*	Özdikmen	Czech Republic, Netherlands, Switzerland		
Pteromalidae	*Rhicnocoelia grahami*	Bouček	Belgium, Czech Republic		
Pteromalidae	*Rhicnocoelia impar*	(Walker)	Belgium, Netherlands		
Pteromalidae	*Scutellista caerulea*	(Fonscolombe)	France, Netherlands, Czech Republic		
Pteromalidae	*Seladerma tarsale*	(Walker)	Belgium, Czech Republic, Netherlands		
Pteromalidae	*Spilomalus quadrinota*	(Walker)	Czech Republic, Netherlands		
Pteromalidae	*Stenomalina fervida*	Graham	Belgium, Czech Republic		
Pteromalidae	*Stichocrepis armata*	Förster	Austria, Czech Republic, Netherlands, Switzerland		
Pteromalidae	*Stinoplus pervasus*	(Walker)	Czech Republic, France, Netherlands		
Pteromalidae	*Synedrus transiens*	(Walker)	Czech Republic, Netherlands		
Pteromalidae	*Systasis annulipes*	(Walker)	Czech Republic, Netherlands		
Pteromalidae	*Systasis parvula*	Thomson	Belgium, Czech Republic, Netherlands		
Pteromalidae	*Tomicobia promulus*	(Walker)	Austria, Belgium, Czech Republic		
Pteromalidae	*Toxeuma subtruncatum*	Graham	Czech Republic, Belgium, Netherlands		
Pteromalidae	*Trichomalopsis submarginata*	(Thomson)	Czech Republic, Netherlands		
Pteromalidae	*Trigonoderus sokanowskii*	Novicky	Denmark, Switzerland		
Pteromalidae	*Trychnosoma punctipleura*	(Thomson)	Czech Republic, France, Netherlands		
Pteromalidae	*Veltrusia rara*	Bouček	Czech Republic, Netherlands		
Signiphoridae	*Clytina giraudi*	Erdös	Czech Republic, Denmark		
Torymidae	*Exopristus trigonomerus*	(Masi)	Czech Republic, France		
Torymidae	*Idiomacromerus mayri*	(Wachtl)	Austria, Czech Republic, France		
Torymidae	*Megastigmus milleri*	Milliron	Belgium, Denmark, France, Netherlands		
Torymidae	*Megastigmus rafni*	Hoffmeyer	Belgium, Denmark, France, Netherlands		
Torymidae	*Megastigmus specularis*	Walley	Denmark, France, Netherlands		
Torymidae	*Monodontomerus rugulosus*	Thomson	France, Austria, Czech Republic, Netherlands		

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family	species	author	distribution	revision (year)	single record (year)
Torymidae	*Podagrion splendens*	Spinola	Czech Republic, France		
Torymidae	*Pseudotorymus krygeri*	Hoffmeyer	Denmark, Netherlands		
Torymidae	*Torymus aceris*	Bouček	Czech Republic, France		
Torymidae	*Torymus acrophilae*	Ruschka	Austria, Belgium, Czech Republic		
Torymidae	*Torymus amurensis*	(Walker)	Austria, Czech Republic, France, Netherlands		
Torymidae	*Torymus anthobiae*	Ruschka	Austria, Netherlands		
Torymidae	*Torymus calcaratus*	Nees	Belgium, Czech Republic, France, Austria, Netherlands		
Torymidae	*Torymus chlorocopes*	Boheman	Czech Republic, Netherlands		
Torymidae	*Torymus corni*	Mayr	Austria, Czech Republic, France		
Torymidae	*Torymus cupreus*	(Spinola)	Czech Republic, Austria, Denmark, Netherlands		
Torymidae	*Torymus curticauda*	Graham & Gijswijt	Czech Republic, Netherlands		
Torymidae	*Torymus curtisi*	Graham & Gijswijt	France, Austria		
Torymidae	*Torymus euphorbiae*	(Walker)	France, Austria		
Torymidae	*Torymus filipendulae*	Graham & Gijswijt	Czech Republic, Netherlands		
Torymidae	*Torymus giraudianus*	(Hoffmeyer)	France, Austria		
Torymidae	*Torymus grahami*	Bouček	Czech Republic, France		
Torymidae	*Torymus hederae*	(Walker)	Czech Republic, France, Netherlands		
Torymidae	*Torymus hylesini*	Graham	Czech Republic, France, Netherlands		
Torymidae	*Torymus juniperi*	(Linnaeus)	France, Austria, Czech Republic		
Torymidae	*Torymus nigritarsus*	(Walker)	Czech Republic, France, Netherlands, Austria		
Torymidae	*Torymus orobi*	Mayr	France, Austria		
Torymidae	*Torymus pulchellus*	Thomson	Czech Republic, Netherlands		
Torymidae	*Torymus purpurascens*	(Fabricius)	France, Czech Republic		
Torymidae	*Torymus scaposus*	(Thomson)	Czech Republic, Netherlands		
Torymidae	*Torymus socius*	Mayr	Austria, Czech Republic, France		
Torymidae	*Torymus stenus*	Graham	Czech Republic, Netherlands		
Torymidae	*Torymus thymi*	Ruschka	Czech Republic, Denmark		
Torymidae	*Torymus veronicae*	Ruschka	Austria, Belgium		
Trichogrammatidae	*Bloodiella andalusica*	Nowicki	France, Poland		
Trichogrammatidae	*Chaetostricha dimidiata*	Walker	Czech Republic, Denmark		
Trichogrammatidae	*Chaetostricha doricha*	(Walker)	Czech Republic, Denmark		
Trichogrammatidae	*Mirufens longicauda*	(Blood)	Czech Republic, France, Poland		
Trichogrammatidae	*Monorthochaeta nigra*	Blood	Czech Republic, France		
Trichogrammatidae	*Oligosita collina*	Walker	Czech Republic, France		
Trichogrammatidae	*Oligosita engelharti*	Kryger	Czech Republic, Denmark, Poland		
Trichogrammatidae	*Oligosita impudica*	Kryger	Netherlands, Czech Republic, Denmark		

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Trichogrammatidae	*Oligosita pallida*	Kryger	Czech Republic, Denmark, Netherlands		
Trichogrammatidae	*Paracentrobia zabinskii*	(Novicki)	Poland, France		
Trichogrammatidae	*Pseudoligosita gracilior*	(Nowicki)	Czech Republic, France		
Trichogrammatidae	*Pseudoligosita lutulenta*	(Nowicki)	Czech Republic, France		
Trichogrammatidae	*Pseudoligosita podolica*	(Nowicki)	Czech Republic, France, Poland		
Trichogrammatidae	*Tumidiclava bimaculata*	(Blood)	Austria, Czech Republic, France		
Trichogrammatidae	*Ufens similis*	(Kryger)	Denmark, France, Poland		
Trichogrammatidae	*Uscana fumipennis*	(Blood)	Czech Republic, Denmark, Poland		

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Larval development stages and husbandry of the Rice Frog *Microhyla mukhlesuri* Hasan et al., 2014 (Anura: Microhylidae)

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Abstract. We describe captive management and larval development of *Microhyla mukhlesuri*, a recently described microhylid frog from Bangladesh, southern Yunnan, Thailand, Laos, and Vietnam, at the scientific animal keeping facility of the Zoological Research Museum Alexander Koenig (ZFMK). Beginning at Gosner stage 25, for each larval stage detailed characteristics are provided and additionally developmental time is compared to other members of the genus *Microhyla*. Herein, we present first observations on captive reproduction of the species.

Key words. Conservation breeding, larval staging, tadpole morphology.

INTRODUCTION

The genus *Microhyla* Tschudi, 1838 currently comprises 41 species of small ground-dwelling frogs which are commonly referred to as rice frogs (Frost 2018). The group is widely distributed across Asia, occurring from the Japanese Ryukyu Islands and China to the north, across India, Sri Lanka and South-east Asia to the islands Sumatra, Borneo, Java, and Bali in the southeast (Frost 2018). Morphological characteristics comprise a generally small body size and a narrow mouth, a brown to reddish dorsal coloration with variable dark markings, smooth skin on dorsum, absence of vomerine teeth and paratoid glands, fingers without webbing and a hidden tympanum covered with skin (Poyarkov et al. 2014; Seshradi et al. 2016).

Microhyla mukhlesuri Hasan, Islam, Kuramoto, Kurabayashi & Sumida, 2014 was recently separated from its sister taxon *M. fissipes* Boulenger, 1884 and is not yet listed by the IUCN Red List of Threatened Species (Hasan et al. 2014; IUCN 2018). Yuan et al. (2016) suggested that *M. mukhlesuri* is distributed in Bangladesh, southern Yunnan, Thailand, Laos, and Vietnam and thus suppose that it also occurs in Myanmar and Cambodia, resulting in a wide distribution in Southeast Asia. For a few microhylid species of the genus *Microhyla* information on breeding ecology, captive management, and also larval staging tables are available (e.g., Shimizu & Ota 2003; Narzary & Bordoloi 2013; Wang et al. 2017). There is still a lack of information on the ecology and life history, including larval development, of *M. mukhlesuri*. Although this species might currently not be threatened by extinction, there are at least three species in the genus *Microhyla* that are currently listed as Endangered (i.e., *M. pulchella* Poyarkov, Vassilieva, Orlov, Galoyan, Tran, Le, Kretova & Geissler, 2014, *M. sholigari* Dutta & Ray, 2000 and *M. zeylanica* Parker & Osman-Hill, 1949) and one even as Critically Endangered (i.e., *M. karunaratnei* Fernando & Siriwardhane, 1996) by the respective IUCN Red List accounts (Biju et al. 2004; Manamendra-Arachchi & de Silva 2004a; Manamendra-Arachchi & de Silva 2004b; IUCN SSC Amphibian Specialist Group 2017). Therefore, captive management and information on larval development of *M. mukhlesuri* presented in this paper might be used analogously for more threatened closely related species.

Herein, we describe different tadpole stages of *Microhyla mukhlesuri* for the first time and present our captive management methods for this species in the scientific animal keeping facility of the Zoological Research Museum Alexander Koenig (ZFMK), Bonn, Germany. Furthermore, we documented the tadpoles' body surface every two to three days to examine general growth within the larval stage.

MATERIAL AND METHODS

Species identification. Since *Microhyla* species are often cryptic and hence hard to distinguish from each other, species identification was confirmed by DNA barcoding

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Fig. 1. Live specimens of *Microhyla mukhlesuri* at the ZFMK. A: adult frog; B: juvenile frog one week after metamorphosis.

Table 1. Developmental data of the fastest developing tadpoles. Stage: developmental stage according to Gosner (1960); Age: number of days after hatching; Diagnostic features: characteristic features of the respective stage; L: length, D: diameter.

Stage	Age [d]	Diagnostic features
25	1	Body nearly transparent, single pigment cells visible on whole body, wide mouth with obvious mouthparts, well developed eyes, closed operculum covers gills, spiracle forms ventrally on left side
26	10	Hind limb buds start to develop (L < ½ D)
27	12	Further development of hind limb buds (L ≥ ½ D)
28	14	Further development of hind limb buds (L ≥ D)
29	–	Further development of hind limb buds (L ≥ 1.5 D)
30	16	Further development of hind limb buds (L ≥ 2 D), limbs become slightly bent
31	17	Foot paddle starts to develop
32	19	First slight indentation on foot paddle visible (between toes 4 and 5)
33	19	Second indentation on foot paddle visible (between toes 3 and 4)
34	21	Third indentation on foot paddle visible (between toes 2 and 3)
35–36	24	Fourth indentation on foot paddle visible (between toes 1 and 2)
37	27	All toes completely separated
38–39	–	Metatarsal tubercle and subarticular tubercle appear
40	30	Foot tubercles, toe pads completely developed
41	32	Forelimbs visible under the transparent skin, atrophy of the mouthparts begins
42	33	Forelimbs emerge, mouth positioned anterior to nostril
43	35	Mouth angle between nostril and eye, tail begins to atrophy
44	35	Mouth angle beneath eye, tail already strongly reduced
45	36	Mouth angle posterior to eye, only a tail stub is left; coloration and pattern slightly developed
46	37	Tail completely resorbed, metamorphosis completed; development of coloration and pattern completed

using a fragment of the mitochondrial 16S rRNA. Sequences were obtained as described in Koch et al. (2013). The final sequence (GenBank Accession MH232034) was compared with sequences of *Microhyla* species available in GenBank and following the definition of *M. mukhlesuri* as proposed by Yuan et al. (2016).

Captive management of adult frogs. A group of 20 adult *Microhyla mukhlesuri* (Fig. 1A) originating from Vietnam was purchased from a commercial importer in 2017 and housed in a terrarium measuring 60 x 60 x 40 cm (l x w x h) in the scientific animal keeping facility of the ZFMK. The terrarium was filled with remineralized osmosis water up to a depth of about 5 cm. One half of the bottom was covered with a filter pad measuring 40 x 20 x 6 cm as land part. Leaf litter (mainly *Fagus sylvatica* and *Quercus robur*) was scattered on the filter pad and in the water part to provide hiding places. Additionally, some live plants (i.e., *Elodea* sp. and *Microsorum pteropus*) were placed in the water. Both air and water temperatures ranged from 20 °C to 26 °C and humidity varied between 60% and 80%. For illumination LED light strips (Solar Stinger 1100mm Sunstrip Dimmable Driver) were used and the photoperiod was set between 8:00 and 20:00 h. The frogs were fed with young crickets (*Acheta domesticus* and *Gryllus assimilis*) and flightless fruit flies (*Drosophila melanogaster* and *D. hydei)* every two to three days. All prey items were dusted with different vitamin and mineral powders (i.e., herpetal Amphib, herpetal Mineral + Vitamin D3 and herpetal Complete Terrarium) and furthermore crickets were gut loaded with fresh vegetables.

Rearing setup for tadpoles. Tadpoles were transferred into a rearing tank measuring 30 x 30 x 30 cm. This tank was filled with remineralized osmosis water to a depth of about 25 cm and an aquarium heater (SERA SE008710, 50W) was used to keep the water temperature at 24 °C to 25 °C. A few aquatic plants (i.e., *Elodea* sp. and *Microsorum pteropus*) and some dried leaves of *Terminalia catappa* and *Fagus sylvatica* were added to the water as natural bacteriostatics and fungistatics (Chitmanat et al. 2005). Tadpoles were fed with a mixture of crushed fish food (Sera® vipan and Tetra Tablets TabiMin) and *Spirulina* flakes every two to three days. In addition, one stone that was overgrown with algae was placed in the tank and was replaced every other day when most of the algae were eaten. Furthermore, *Daphnia pulex* and different aquatic snails (i.e., *Physella* sp. and *Planorbella* sp.) were added to eat possible food remains. As no filtration was used, half of the water was changed once per week.

The following water parameters were measured in the rearing tank: NO_2 < 0.05 mg/l, NO_3 7.5 mg/l, NH_4 < 0.05 mg/l, Cu < 0.1 mg/l, KH 3°dH, GH 5°dH, pH 6.5–

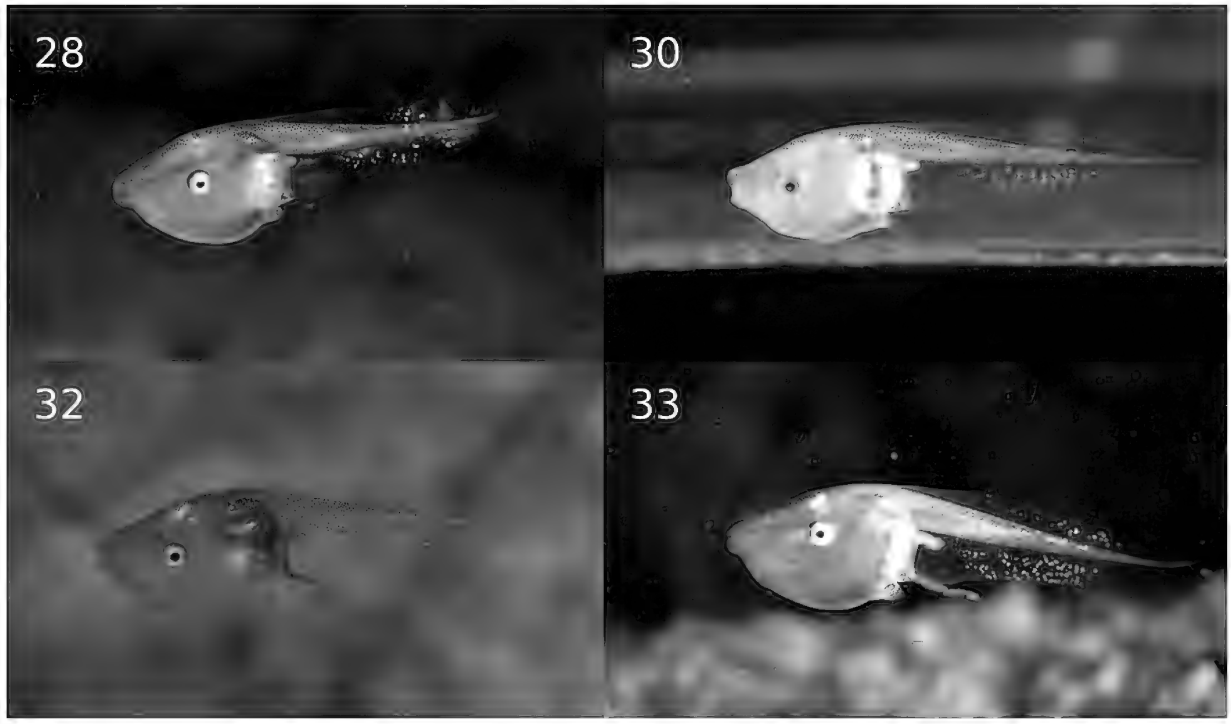

Fig. 2. Tadpoles of *Microhyla mukhlesuri* in Gosner stages 28 to 33. These stages are defined by the growth of hind limbs and foot paddles. Stage 28: hind limbs just became longer than wide (diameter); Stage 30: hind limbs are at least two times as long as wide (diameter); Stage 32: a first indentation appears on the foot paddles, which will later separate toes 4 and 5; Stage 33: second indentation appears on the foot paddles between the developing toes 3 and 4.

Table 2. Comparative larval development time of four species in the genus *Microhyla*: *M. mukhlesuri*, *M. fissipes*, *M. ornata*, *M. okinavensis*. We adjusted the staging data of the other species to fit the staging system after Gosner (1960) and started counting from stage 25 onwards. * The species identified as *M. ornata* by Narzary & Bordoloi (2013) might in fact be *M. mukhlesuri* following Yuan et al. (2016), genetic analyses are necessary; ** Specimens from the Ryukyu Archipelago identified as *M. ornata* by Shimizu & Ota (2003) have been assigned to *M. okinavensis* by Matsui et al. (2005).

	Age [d]			
Stage	***Microhyla mukhlesuri*** (Own data)	***Microhyla fissipes*** (modified after Wang et al. 2017)	***Microhyla ornata**** (modified after Narzary & Bordoloi 2013)	***Microhyla okinavensis**** (modified after Shimizu & Ota 2003)
25	1	1	1.0	1.0
26	10	6	2.5	5.5
27	12	9	3.0	7.5
28	14	12	7.5	9.5
29	–	15	12.5	11.5
30	16	15	16.5	11.5
31	17	17	19.5	13.5
32	19	19	22.5	15.5
33	19	19	25.5	15.5
34	21	22	28.5	17.5
35	24	24	31.5	18.5
36	24	24	33.5	18.5
37	27	26	35.5	20.5
38	–	29	38.5	23.5
39	–	33	40.5	29.5
40	30	33	41.5	29.5
41	32	36	42.5	33.5
42	33	38	43.5	35.5
43	35	38	44.0	35.5
44	35	39	44.5	36.5
45	36	40	45.5	37.5
46	37	41	46.5	38.5

7.5. Lighting was equivalent to the adult setup. When the first tadpoles had developed hind legs a piece of cork bark was added to the aquarium to provide a small land area for metamorphosed frogs.

Rearing setup for juvenile frogs. Metamorphosed frogs were transferred into plastic boxes measuring 33 x 21 x 28 cm with fine mesh lids on both narrow sides. One side of this container was heightened to create a gradient and a water part with a depth of about 2 cm on the lower side. One layer of Hygrolon®, an artificial and highly hygroscopic material originally developed for cultivating orchids and ferns, was used as ground layer to keep the air humidity on a high level of about 70% to 80%. Furthermore, a big layer of dry leaves (mainly *Fagus sylvatica* and *Quercus robur*) and moss was added to the box. Temperatures ranged between 21 °C and 26 °C and illumination was the same as in the adult and tadpole setups. In the first few weeks after metamorphosing the juvenile frogs were fed with tropical springtails (*Collembola* sp.), later on they were additionally fed with dusted *Drosophila hydei*.

Data acquisition and evaluation. To document growth and development of the tadpoles every two to four days photos of 10 randomly chosen tadpoles were taken from 10th of June to 1st of September 2017. On the last day of growth documentation only the five remaining larvae, which had not completed metamorphosis at that time, were photographed. For this the tadpoles were transferred into a Petri dish, which was lightened from below to increase the contrast between tadpole and background in the recorded photos. All photos were taken with a digital camera (Olympus TG-2). Additionally, morphological data of the fastest developing tadpoles were recorded to document the developmental stages. The photos were

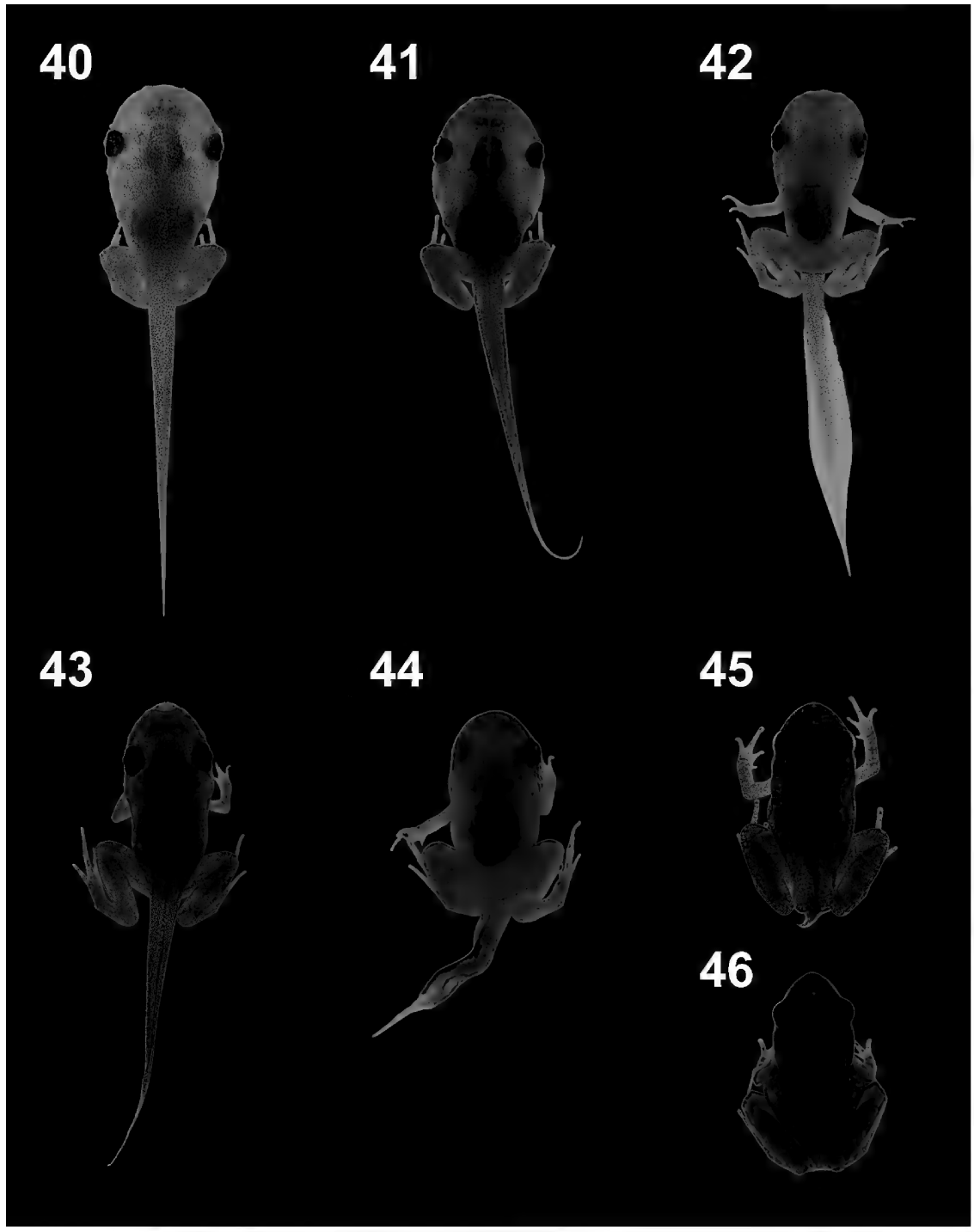

Fig. 3. Gosner stages 40 to 46 of *Microhyla mukhlesuri* tadpoles, representing the last steps to metamorphosis. Stage 40 (dorsal view): development of hind limbs and toe pads is completed and foot tubercles have developed; Stage 41 (dorsal view): the forelimbs have become well visible under the tadpoles' transparent skin, the mouthparts begin to atrophy; Stage 42 (ventral view): both fully developed forelimbs have emerged, mouth angles are positioned anterior to the nostrils; Stage 43 (dorsal view): tail degeneration begins, mouth angle is positioned between nostril and eye; Stage 44 (ventral view): the tail is already strongly reduced and the mouth angles are now positioned beneath the eyes; Stage 45 (dorsal view): the tail is greatly reduced and the mouth angles are positioned posterior to the eyes, additionally, the coloration has already slightly developed; Stage 46 (dorsal view): with the completed reduction of the tail and further development of the coloration, metamorphosis is finished.

analyzed with the tool SAISAQ (Kurth et al. 2014) on the open source statistics platform R (R Developmental Core Team 2016). This software package semiautomatically processes image files and computes the surface area of a tadpole, which is highly correlated with its body mass. This method is non-invasive and therefore suitable for repeated measurements on (small) live animals without causing much handling stress. Larval stages were examined following the universal anuran larvae staging table developed by Gosner (1960). We identified tadpole stages between Gosner stage 25 and 46, starting with the stage in which the tadpoles were found and finishing with completion of metamorphosis. Voucher specimens were deposited in the herpetological collection of the Zoological Research Museum Alexander Koenig, Bonn (ZFMK 101119−101122 [adults], ZFMK 101528 [juvenile], ZFMK 101529 [metamorph]), and ZFMK 101530 – 101531 [larvae]).

RESULTS

A total of 79 tadpoles were found on 10th of June 2017 in the water part of the adult breeding group terrarium, no unhatched or unfertilized eggs were left. When detected, all tadpoles were free swimming without yolk sac and showed a strong fleeing reaction when disturbed. They had a mainly transparent body with scattered pigment cells, a wide mouth with already completely developed mouthparts, and the gills were covered by the operculum. Following these features, we determined them as Gosner stage 25 at the day of finding (Table 1). At this stage, tadpoles had a mean body surface of about 0.057 cm² (Fig. 4). Stages 26 to 30 ranged from day 10 to day 16 and were defined by different growth stages of the hind limb buds (Fig. 2). We were not able to differentiate stage 29. At stage 30, the limbs became slightly bent. The following stages 31 to 37 were characterized by the development and indentation of the foot paddle, finishing with the complete separation of all toes, and lasted from day 17 to 27 (Fig. 2). Stages 38 and 39 were not documented. On day 30 the first tadpoles reached stage 40, characterized by developed foot tubercles and the completion of the toe pads. Stages 41 to 46, the metamorphs stages, were characterized by the completion of metamorphosis and ranged from days 32 to 37 (Fig. 3). At stage 41 the developed forelimbs were well visible under the tadpoles' transparent skin. Additionally, the atrophy of the mouthparts began in this stage. Forelimbs emerged at stage 42 at day 33, and the mouth angle was positioned anterior to the nostril. Within the next three stages the mouth angles became translocated more to the distal end of the tadpoles' head, until they were positioned posterior to the eyes at stage 45 at day 36. Furthermore, absorption of the tail began in stage 43 and was finished in stage 46.

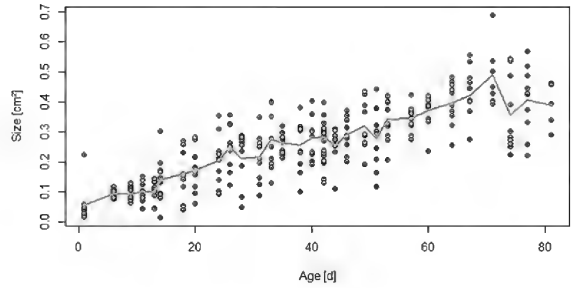

Fig. 4. General growth in tadpoles of *Microhyla mukhlesuri*, based on body surfaces computed with SAISAQ (Kurth et al. 2014). Blue spots represent sizes of individual tadpoles; mean size at the respective day is plotted in the red graph.

Together with the fully developed coloration at this stage (Fig. 1B), the metamorphosis was completed. The fastest developing tadpole finished metamorphosis as early as day 37 after finding, the slowest developing one at day 98, while most (32) metamorphosed between day 73 and 80. Body surface reached its highest peak at day 71 with a mean surface of 0.490 cm² and the biggest individual measuring 0.689 cm² (Fig. 3). Afterwards, when most tadpoles reabsorbed their tail to finish metamorphosis, general body surface decreased slightly. Directly after the completion of metamorphosis the freshly morphed frogs measured between 0.221 cm² and 0.333 cm², and had a snout-vent length of 6 mm to 7 mm.

DISCUSSION

Our results summarize the first larval staging for free-swimming tadpole stages of *Microhyla mukhlesuri*. As only already hatched tadpoles were found, we were not able to document early embryonic stages of this species. Future captive breeding efforts at the scientific animal keeping facility of the ZFMK will be necessary to complete the staging table.

We assume that the tadpoles had hatched only one or two days before we found them in the breeding group tank. Hence, based on our study tadpoles needed between 38–40 and 98–100 days to complete metamorphosis at water temperatures of 24 °C to 25 °C. This is very similar to the findings of Wang et al. (2017) for the closely related sister taxon *Microhyla fissipes*, which needed 43 days in total and about 41 days after hatching in late stage 23 to complete the metamorphosis at a water temperature of 22.9 °C to 25.4 °C. Furthermore, we found high similarities to other species of the genus *Microhyla*. Measuring from stage 25 onwards, tadpoles of *M. ornata* complete metamorphosis in about 46.5 days at a water temperature of 25 °C to 27 °C (Narzary & Bordoloi 2013), and tad-

poles of *M. okinavensis* in about 38.5 days at 19 °C to 26 °C (Shimizu & Ota 2003). Detailed comparisons of developmental time of different tadpole stages are documented in Table 2. Mohammad Ridzuan (2013) found that tadpoles of *M. nepenthicola* needed 14 days from stage 33 to stage 46, while tadpoles of the aforementioned species needed 18 to 23 days (i.e., *M. mukhlesuri*: 18 d, *M. fissipes*: 22 d, *M. ornata*: 21 d, *M. okinavensis*: 23 d; Table 2). This difference might be due to different rearing setups, especially temperature (information missing for *M. nepenthicola*) and amount of provided food usually have high influences on the rate of larval development (e.g., Duellman & Trueb 1986; Harkey & Semlitsch 1988; Marian & Pandian 1985).

The number of tadpoles we found (n=79) is rather small compared to clutch sizes reported for *M. fissipes* (209 to 564 eggs [Wang et al. 2017]), *M. ornata* (300 to 510 eggs [Narzary & Bordoloi 2013]) and *M. okinavensis* (220 to 910 eggs [Shimizu & Ota 2003]). Hence, we suppose that it was either the first clutch of a recently sexually matured and still not fully grown female, which might produce smaller egg clutches (e.g., Gibbons & McCarthy 1986), or that the majority of either eggs, possibly infertile eggs, or tadpoles had already been eaten by adult frogs. Future breeding efforts might help to collect sufficient data on clutch sizes.

The combined information about larval development, captive breeding and management of these frogs gathered in different studies might become an important factor if measures of conservation necessitate captive breeding programs for the preservation of endangered species and for restocking programs. Currently, the IUCN Red List of Threatened Species (2018) lists four species of the genus *Microhyla* as Endangered or even Critically Endangered (i.e., *M. pulchella*, *M. sholigari*, *M. zeylanica* and *M. karunaratnei*). Furthermore, for seven species of the genus there is not yet enough data available for a classification by the IUCN Red List and ten species are not even listed at all (Frost 2018; IUCN Red List of Threatened Species 2018). The endangered species might benefit from the knowledge gained in our and similar studies as husbandry analogues already today.

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REFERENCES

Biju SD, Dutta S, Bhuddhe GD, Vasudevan K, Srinivasulu C (2004) *Microhyla sholigari*. The IUCN Red List of Threatened Species 2004: e.T57893A11688938. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T57893A11688938.en. Downloaded on 09 April 2018

Chitmanat C, Tongdonmuan K, Khanom P, Pachontis P, Nunsong W (2005) Antiparasitic, antibacterial, and antifungal activities derived from a *Terminalia catappa* solution against some Tilapia (*Oreochromis niloticus*) pathogens. Acta Horticulturae 678: 179–182

Duellman WE, Trueb L (1986) Biology of amphibians. McGraw-Hill, New York

Frost DR (2018) Amphibian species of the world: an online reference. Version 6.0 (Date of access 18. April 2018). Electronic Database accessible at http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York, USA

Gibbons MM, McCarthy TK (2011) The reproductive output of frogs *Rana temporaria* (L.) with particular reference to body size and age. Journal of Zoology 209: 579–593

Gosner KL (1960) A simplified table for staging anuran embryos and larvae with notes on identification. Herpetologica 16: 183–190

Harkey GA, Semlitsch RD (1988) Effects of temperature on growth, development, and color polymorphism in the Ornate Chorus Frog *Pseudacris ornata*. Copeia 1988: 1001–1007

Hasan M, Islam M, Kuramoto M, Kurabayashi A, Sumida M (2014) Description of two new species of *Microhyla* (Anura: Microhylidae) from Bangladesh. Zootaxa 3755: 401–418

IUCN Red List of Threatened Species. Version 2017-3. <www.iucnredlist.org>. Downloaded on 10 April 2018

IUCN SSC Amphibian Specialist Group. (2017) *Microhyla pulchella*. The IUCN Red List of Threatened Species 2017: e.T73728100A73728104. http://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T73728100A73728104.en. Downloaded on 09 April 2018

Koch C, Venegas PJ, Rödder D, Flecks M, Böhme W (2013) Two new endemic species of *Ameiva* (Squamata: Teiidae) from the dry forest of northwestern Peru and additional information on *Ameiva concolor* Ruthven, 1924. Zootaxa 3745: 263–295

Kurth M, Hörnes D, Rödder D (2014) SAISAQ: A novel tool for semiautomatic image based surface area quantification. North-Western Journal of Zoology 10: 217–220

Manamendra-Arachchi K, de Silva A (2004a) *Microhyla karunaratnei*. The IUCN Red List of Threatened Species 2004: e.T57883A11686175. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T57883A11686175.en. Downloaded on 09 April 2018

Manamendra-Arachchi K, de Silva A (2004b) *Microhyla zeylanica*. The IUCN Red List of Threatened Species 2004: e.T57895A11689438. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T57895A11689438.en. Downloaded on 09 April 2018

Marian MP, Pandian TJ (1985) Effect of temperature on development, growth and bioenergetics of the bullfrog tadpole *Rana tigrina*. Journal of Thermal Biology 10: 157–161

Mohammad Ridzuan ASB (2013) Staging of late larval developmental stages of the microhylid frog, *Microhyla nepenthicola* (Anura: Microhylidae). University of Malaysia Sarawak (Bachelor Thesis)

Narzary J, Bordoloi S (2013) Study of normal development and external morphology of tadpoles *of Microhyla ornata* and *Uperodon globulosus* of the family Microhylidae (Amphibia: Anura) from North East India. International Journal of Advanced Biological and Biomedical Research 3: 61–73

Poyarkov NA, Vassilieva AB, Orlov NL, Galoyan EA, Dao Tran Thi Anh, Le DTT, Kretova VD, Geissler P (2014) Taxonomy and distribution of narrow-mouth frogs of the genus *Microhyla* Tschudi, 1838 (Anura: Microhylidae) from Vietnam with descriptions of five new species. Russian Journal of Herpetology 21: 89–148

R Development Core Team (2016): A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria

Shimizu S, Ota H (2003) Normal development of *Microhyla ornata*: the first description of the complete embryonic and larval stages for the microhylid frogs (Amphibia: Anura). Current Herpetology 22: 73–90

Seshadri KS, Singal R, Priti H, Ravikanth G, Vidisha MK & Saurabh S, Pratik M, Kotambylu VG (2016) *Microhyla laterite* sp. nov., a new species of *Microhyla* Tschudi, 1838 (Amphibia: Anura: Microhylidae) from a laterite rock formation in south west India. PLoS ONE 11(3): e0149727

Wang S, Zhao L, Liu L, Yang D, Khatiwada J, Wang B, Jiang J (2017) A complete embryonic developmental table of *Microhyla fissipes* (Amphibia, Anura, Microhylidae). Asian Herpetological Research 8: 108–117

Yuan ZY, Suwannapoom C, Yan F, Poyarkov NA, Nguyen SN, Chen HM, Chomdej S, Murphy RR, Che J (2016) Red River barrier and Pleistocene climatic fluctuations shaped the genetic structure of *Microhyla fissipes* complex (Anura: Microhylidae) in southern China and Indochina. Current Zoology 62: 531–543

Bonn zoological Bulletin 67 (2): 117–128
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Developmental Ecology and Larval Staging in *Polypedates otilophus* (Boulenger, 1893) (Anura: Rhacophoridae)

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Abstract. Tadpoles of *Polypedates otilophus* originating from two different foam nests were raised at water temperatures between 19°C and 27°C. A larval staging table according to Gosner is provided for the first time for the genus. The clutch sizes of the foam nests differed (19 and 49 eggs, respectively), but only 14 and 17 tadpoles hatched at stage 25. The first tadpole of nest one completed metamorphosis after 120 days and the first tadpole of nest two after 131 days. Before metamorphosis is completed, the metamorphs developed significant brown striation which is first visible on the hind legs and subsequently also on the dorsal side of the body. Detailed characteristics of each larval stage are provided. We herein provide the first detailed report on the larval development of *P. otilophus*, which can be used as surrogate species for captive management of other *Polypedates* taxa. Most interestingly, the temporal development of larvae in this species appears to be extremely plastic and strongly depending on ambient temperature.

Key words. Developmental ecology, tadpole morphology, environmental plasticity.

INTRODUCTION

The genus *Polypedates*, which is distributed in Eastern India, southeastern Asia, the Philippines, and Borneo (Frost 2017), was first described by J. J. Tschudi in 1838. Currently 24 species of the genus are recognized (Frost 2017) and 15 are listed at the IUCN Red List of Threatened Species (IUCN 2017). One species is listed as "Endangered" (*Polypedates insularis* Das, 1995) and four species are listed as "Data Deficient" by IUCN (*Polypedates chlorophthalmus* Das, 2005; *P. hecticus* Peters, 1868; *P. occidentalis* Das & Dutta, 2006; and *P. zed* [Dubois, 1986]) and ten species are listed as Least Concern (*Polypedates colletti* [Boulenger, 1890]; *P. cruciger* Blyth, 1852; *P. leucomystax* [Gravenhorst, 1829]; *P. macrotis* [Boulenger, 1891]; *P. maculatus* [Gray, 1830]; *P. megacephalus* Hallowell, 1860; *P. mutus* [Smith, 1940]; *P. otilophus* [Boulenger, 1893]; *P. pseudocruciger* Das & Ravichandran, 1998; and *P. taeniatus* [Boulenger, 1906]; IUCN 2017).

Polypedates otilophus was first described as *Rhacophorus otilophus* by Boulenger in 1893, who characterized *Rhacophorus otilophus* by its much depressed head which is large and a little broader than long. Furthermore, according to the original description, it possesses a pointed snout which is a little longer than the diameter of the orbit and a nostril which is close to the tip of the snout. The forehead is concave and the fingers long with rudimentary webs. The tips are dilated into rather large disks and the toes are two-thirds webbed, but the disks are smaller than those of the fingers. The skin texture of the dorsum is finely granular, whereas the skin of the belly and the lower surface of the thighs are coarsely granular. The dorsal coloration is pale olive with dark grey spots and longitudinal streaks (Fig. 1). Further, the hind limbs are dark cross-banded which become thinner and denser on the concealed surfaces of the hind limbs. Males have internal vocal sacs. A male specimen measured in Bongon, North Borneo, had a snout to vent length (SVL) of 80 mm (Boulenger 1893) and Iskandar (2004) reported that females can reach up to 100 mm SVL.

Polypedates otilophus is listed as Least Concern by IUCN (2017) because of its wide distribution, its presumed large population and because of the tolerance of a degree of habitat modification. According to the most recent assessment the species is unlikely to be declining fast enough to qualify for being listed in a higher threat category. Matsui et al. (2014) noted that the species occurs at many sites in Borneo and on Sumatra at elevations below 1,000 m a.s.l. The species is arboreal prefering lowland forests in flat and hilly terrain. Under natural conditons breeding takes place in temporary rain pools; specimens are also frequently found in disturbed

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Fig. 1. Adult specimen of *Polypedates otilophus*. Photo: M. Flecks.

habitats, such as logged areas at the forest edge, which apparently do not possess a threat (Inger et al. 2004).

There are few studies available reporting on the reproduction and tadpole development of species of the genus *Polypedates*. Tapley and Girgin (2015) raised 14 clutches of *P. otilophus* and reported that tadpoles need 74 to 84 days to reach metamorphosis at 22°C to 26°C. In this study foam nests were five times produced in the early morning about 6 a.m., wherein the entire process of the nest construction took about 45 minutes. Three of the nests, which were dissected within 24 hours, contained 42 to 119 eggs. The authors reported that the tadpoles hatched after approximately ten days and that the first tadpole metamorphosed after 74 days. Metamorphosis within the cohort took place within ten days (Tapley & Girgin 2015).

Chakravarty et al. (2011) reported for *Polypedates teraiensis* the entire development from ovum fertilization up to emergence of the froglet with 58 days at 26°C to 32°C. They examined five different foam nests of which clutch sizes varied between 67 and 127 white-coloured eggs. Some eggs located on the outermost surface of the foam nest sometimes did not develop and turned pale yellow due to desiccation. Embryos of *P. teraiensis* hatched at stage 20 and stayed within the foam nest until stage 22 (*sensu* Gosner 1960). In another study, Tamuly & Dey (2014) reported on the larval morphology and development of *Polypedates teraiensis* within 42 days after hatching at temperatures between 26°C and 33°C. Under these conditions the keratodent jaws developed at Gosner stage 25 and were assimilated at stage 42.

Yorke (1983) presented data on the survival of embryos and larvae for *Polypedates leucomystax*. The average embryonic mortality was 34% in field-collected egg masses, wherein fertilization rates were approximately 100%. The pooled mortility data showed that 98% occurred prior to tail-bud stage. In this study the highest frequency and proportion of mortality occurred in the early neural stages, whereas no embryonic mortality was found beyond tail-bud stages. The mortality increased in stages 31 to 35 (Yorke 1983).

Hsu et al. (2012) stated that breeding in *Polypedates braueri* on the Bagua Terrace takes place from March to August though tadpoles can be found during the entire year, hibernating in man-made water containers in lowland orchands. Laboratory experiments showed that the overwintering is facultative and can be initialized by low temperatures and limited food, wherein the role of food availability was confirmed in the wild (Hsu et al. 2012).

Information on captive breeding of *P. otilophus* is scarce. Iskandar (2004) reported that *P. otilophus* does not do well in captivity. Janzen (2014) and Tapley and Girgin (2015) reported on husbandry and breeding events in captivity. Detailed information on larval staging and development are currently lacking.

Fig. 2. Tanks used for captive breeding of *Polypedates otilophus*: the terrarium of the initial breeding group (A); one of the aquaria used for tadpole raising (B); and one of the terraria for raising the froglets after metamorphosis (C).

MATERIAL AND METHODS

Captive Management and Breeding

In 2014, 27 tadpoles of *Polypedates otilophus* were donated to the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK) by a private German breeder who previously reported on captive management of the species (Janzen 2014). At the time the present study was conducted our breeding group consisted of 20 specimens, which were kept in a terrarium in the animal keeping unit of the ZFMK measuring 60 x 80 x 140 cm lxbxh (Fig. 2A). They were fed ad libitum with adult crickets (*Acheta domesticus* or *Gryllus assimilis*) two or three times per week and irregularly with flies (*Musca domestica*), which were fed with fresh fruit or fruit puree to absorb more vitamins.

The terrarium was divided into two different parts: a land part and a water part (25 x 80 x 18 cm lxbxh) containing a water pump (Eheim Universalpumpe, Typ 1260 210) connected to a sprinkler system and some *Cryptocoryne* sp. The land part consisted of several layers of filter padding reaching a total height of 20 cm and was equipped with different plants (*Monstera deliciosa* and *Syngonium* sp.) and some branches, partly extending from the water part to the land part. The back side as well as the right side of the terrarium were covered with Hygrolon® to keep the humidity high.

Next to natural daylight, LED light strips (Solar Stinger 1100 mm Sunstrip Dimmable Diver) served as light source between 8 a.m. and 8 p.m. In order to stimulate reproduction, the sprinkler system was activated daily for about three hours, resulting in a relative humidity between 65% and 90%. Air temperature varied between 20°C and 30°C and the water temperature varied between 20°C and 28°C.

Under these conditions two foam nests were produced, wherein the first one was attached on a leaf above the water part on February 26, 2017 and the second nest was attached to the glass wall above the water part on March 15, 2017.

Raising of tadpoles and froglets

To provide suitable water conditions fresh osmosis water was remineralized in an aquarium (50 x 40 x 30 cm lxbxh), which was equipped with aquatic plants (*Cryptocoryne* sp.), dried leaves (*Fagus sylvatica*) and circulated with a water pump (Eheim Powerhead 650). After extracting water for exchanges on a weekly basis the aquarium was refilled with fresh osmosis water.

The leaf which contained the first foam nest (group 1) was cut off the plant and placed in a second terrarium (50 x 40 x 40 cm lxbxh) to avoid disturbances of the adults. It was similarly equipped as the terrarium of the adults and automatically sprayed with water three times per day for each 30 seconds. A box (25 x 18 x 7.5 cm lxbxh) providing remineralized osmosis water was placed under the foam nest to allow hatching of group 1 in a monitored environment. The second foam nest could not be placed in a separate terrarium without damage as it was attached to a glass wall. In order to collect the hatching tadpoles of group 2 a plastic box (10 x 10 x 10 cm lxbxh) was placed underneath it. Foam nests were checked daily and hatched tadpoles were moved into aquaria (see below). Both foam nests were torn apart when no tadpole hatched after at least one week and the remaining eggs were counted and photographed. Air and water temperature ranged between 21°C and 22°C during the developmental phase of both groups.

Tadpoles of both groups were separated in two similar aquaria (30 x 30 x 30 cm lxbxh, water level 25 cm) providing equivalent environmental conditions (Fig. 2B). Each aquarium contained aquatic plants (*Cryptocoryne* sp.), algae-covered stones, dried leaves of *Fagus sylvatica*, which served as additional food, and snails (*Physella* sp. and *Planorbella* sp.) to remove food remains. Tadpoles were fed three times per week ad libitum. Due to availability the food composition changed during the larval phase, starting with a mixture of three different minced fish foods (Sera Vipan Großflocke XL-Hauptfutter für alle Zierfische, O.S.I. Spirulina Flakes and Tetra Tablets TabiMin). Tadpoles of group 1 were fed with this mixture until day 108, whereas the tadpoles of group 2 were fed with it until day 91. Later on the tadpoles were

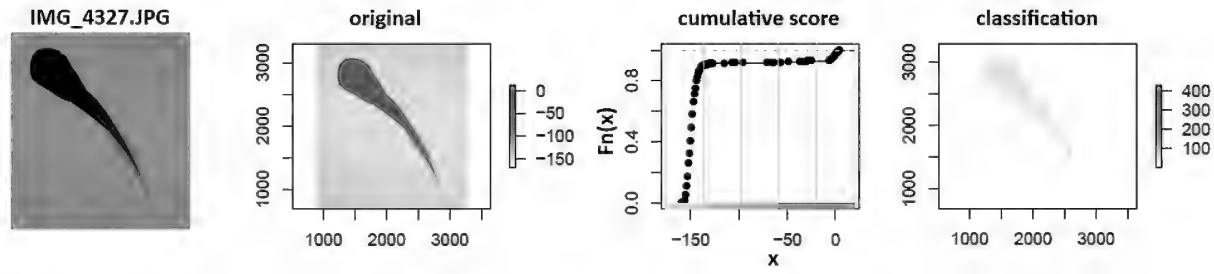

Fig. 3. Example of a tadpole picture which was processed with SAISAQ to calculate the body size. The original photo is transferred into a monochromatic Figure and a threshold is computed to select the most appropriate color intensity to delimit the largest dark object, which in turn is measured in terms of the total number of pixels. Based on this pixel score the surface is computed using a standard.

fed with fish food tablets (Tetra Tablets TabiMin, 1–2 tablets/aquarium).

Two-thirds of the water of each aquarium was exchanged weekly with remineralized osmosis water and the algae-covered stones were exchanged. No artificial light source was provided as the aquaria were placed in a room providing daylight. The water temperature varied between 19°C and 27°C (group 1) and 25°C (group 2). During an unexpected cold period in Germany, the water temperature of both aquariums sank to 19°C which was counterbalanced by a heater (Sera Automatic Heater 50 W), thus reestablishing a minimum of 21°C afterwards. A piece of floating cork was placed in each aquarium to enable the metamorphosed froglets to leave the water.

Froglets were moved to terraria (50 x 40 x 40 cm lxbxh; Fig. 2C) which were equipped similarly to those of the adults, with a filter pad as substrate layer and a small water part (1.5 cm depth) and Hygrolon® to keep humidity high. The terraria were automatically misted with water three times per day for 30 seconds each resulting in a relative humidity between 70 and 90 %. The land parts of both terraria were equipped with *Monstera deliciosa*, *Pilea* sp., bromeliads, different mosses and ferns, and as light source in both terraria LED light strips were used (Solar Stinger 1100 mm Sunstrip Dimmable Diver). The photoperiod was set to daylight hours between 8 a.m. and 8 p.m.. Air temperature varied between 19.0°C and 25.0°C and water temperature between 20.0°C and 25.5°C.

Froglets were fed with flightless fruit flies (*Drosophila melanogaster* and *D. hydei*) and crickets (*Acheta domesticus*) two to three times per week, which were fed with fresh vegetables, fruit or fruit puree to absorb vitamins. Additionally, prey items were dusted with mineral or vitamin powder (herpetal Amphib, herpetal Mineral + Vitamin D3 and herpetal Complete Terrarium).

Data Collection and Evaluation

The development of the nests, tadpoles and froglets was monitored between March 2nd and August 1st, 2017. After the tadpoles hatched, standardized photos were taken of every tadpole every day for a week (Canon Eos 550D) as described in Kurth et al. (2014). Afterwards the interval was extended and photos were taken two to four times per week until day 114 depending on the developmental progress of the tadpoles. When the tadpoles metamorphosed to froglets, photos were taken of every specimen before they were placed into the terrarium belonging to their groups. Photos of the frogs were taken weekly.

The growth of the tadpoles was determined using the SAISAQ pipeline (Kurth et al. 2014), programmed in the open source statistics software R (R Developmental Core Team 2017). SAISAQ analyses photograph files and computes the surface of a tadpole (Fig. 3), which is highly correlated with tadpole mass and can be used to describe body size in tadpoles (Kurth et al. 2014).

RESULTS

Development and Staging

During the night from February 25 to February 26 and the night from March 14 to March 15, the foam nests were produced, while nest 2 was larger and not as compact as nest 1. The part of the foam nest containing the eggs sank in a fluid transition. Both foam nests were beige to yellow coloured becoming darker with drying. On day 9 the foam nest of group 1 showed the first holes when the first tadpoles hatched (Fig. 4). On day 10 and 11, the foam nest sank further. From day 14 onwards, the foam started to disorganize, holes became larger and remaining eggs became visible (Fig. 4). The foam nest of group 2 started disorganization on day 6 and most tadpoles had hatched on day 10 (Fig. 4). The clutch of group 1 contained 49

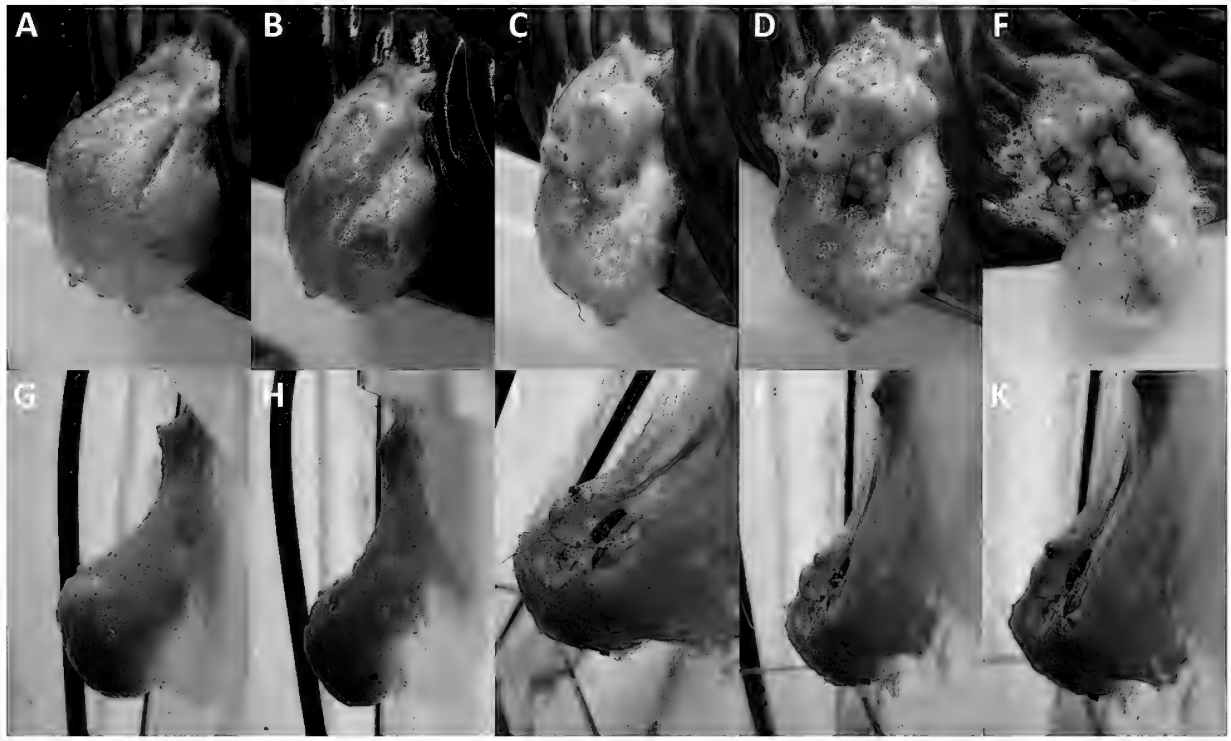

Fig. 4. Foam nests of *Polypedates otilophus*. Upper row shows the development of the nest of group 1 (5, 10, 13, 16, and 19 days), bottom row group 2 (1, 6, 10, 13, and 16 days).

eggs including 35 unhatched eggs, whereas the clutch of group 2 contained 19 eggs including 2 unhatched.

On day 11 the first two tadpoles of group 1 hatched. Afterwards, five tadpoles hatched on day 12 and another five tadpoles the next day. The last two tadpoles hatched on day 14. On day 8 the first tadpole of group 2 hatched. On day 9, thirteen tadpoles hatched and on day 10 the last three did.

A detailed staging table according to Gosner (1960) is provided in Appendix 1 and corresponding photos are provided in Figs 4–5, and 7–9. The tadpoles hatched when they were in Gosner stage 25 (Fig. 6). Between day 21 and day 50 the hind limb buds grew (Fig. 8). On day 41 the first tadpoles of group 1 reached Gosner stage 30. The first tadpoles of group 1 reached stage 31 on day 51. Stages 32 to 36 were hard to identify because the musculature of the tail overlapped the foot bud partly. On day 84 only the first tadpole of group 1 reached stage 37. At this time two tadpoles of group 1 were in stage 30, seven tadpoles of group 1 were in stages 31 to 33 and the remaining three tadpoles of group 1 were in stages 34 to 36. The first tadpole completed metamorphosis after 120 days (group 1). The other tadpoles were slower in their development with the last specimen completing metamorphosis on day 169.

Some tadpoles of both groups showed a spinal curvature in the area between the body and the tail fin (Fig. 9) starting on day 55 when a weak spinal curvature became visible in some tadpoles of group 1. On day 84, most tadpoles of group 1 showed the spinal curvature which became more distinctive in the course of time. The spinal curvature vanished after completing metamorphosis having apparently no effects on the frogs.

Comparing the development in the two groups it became evident that the first froglet of group 2 completed metamorphosis later than the first froglet of group 1, although hatching earlier. In group 1 one specimen developed faster than the remaining cohort while in group 2, the tadpoles metamorphosed shortly after one another (Gosner stages 37 to 40).

Mortality

During the study, five tadpoles died in group 1, and none in group 2. The tadpoles died on days 18, 109, 117, 128 and 137. Noteworthy, other tadpoles fed on dead specimens proving for the first time adelphophagy in *P. otilophus*.

Growth Rate

The tadpoles of group 2, which hatched earlier than the tadpoles of group 1, hatched also with a smaller body size (Fig. 6; group 1: 0.176 cm^2–0.306 cm^2; group2:

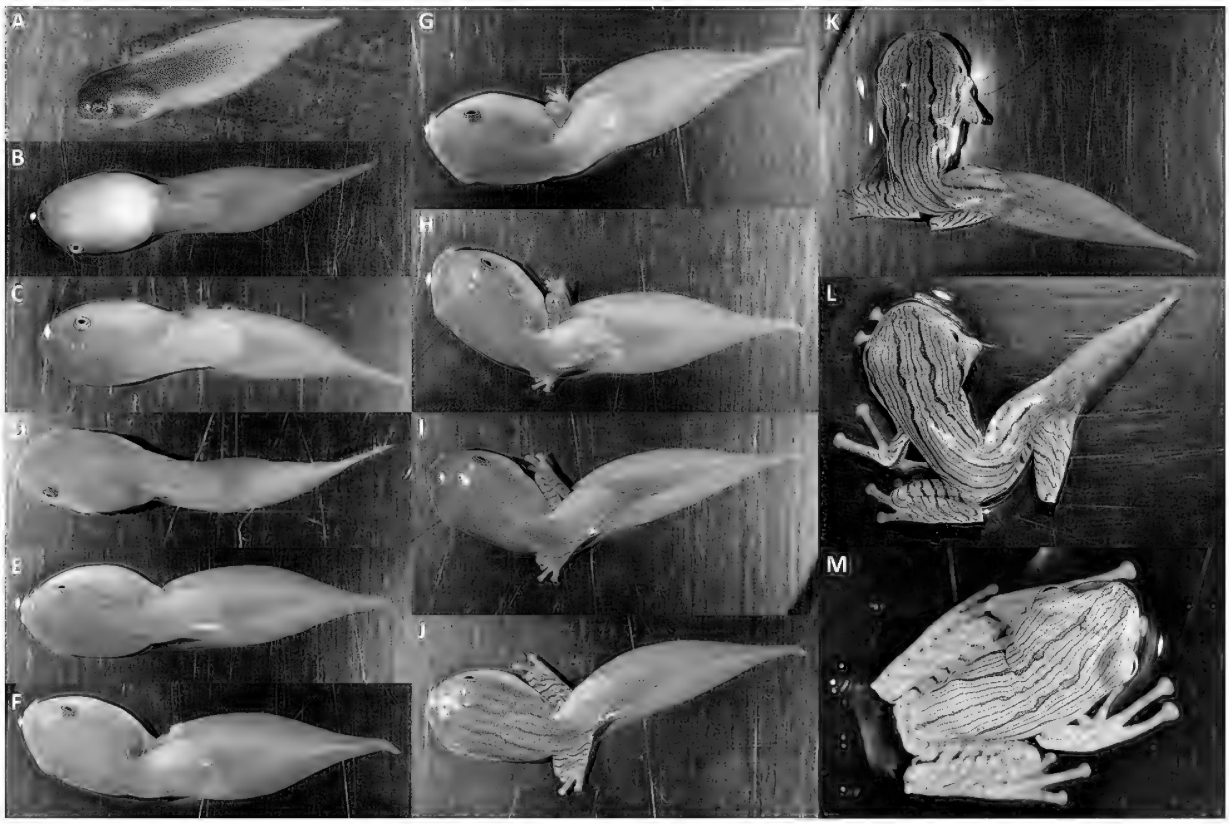

Fig. 5. Larval development of *Polypedates otilophus*. Gosner stage 25, 14 days old (A); stage 25, 39 days, ventral view (B); stage 29–30, 48 days (C); stage 31–32, 59 days (D); stage 36, 81 days (E); stage 37–38, 87 days (F); stage 39, 96 days (G); stage 39–40, 99 days (H); stage 39–40, 102 days (I); stage 39–40, 105 days (J); stage 42, 109 days (K); stage 43–44, 111 days (L); stage 46, 120 days (M).

0.184–0.247 cm^2). Larger body sizes were reached by tadpoles of both groups which hatched last. Body sizes were similar in both groups between day 15 and day 26 (0.7 cm^2). Afterwards, the body sizes differed between the two groups between day 27 and day 67. During this period, the body sizes of group 1 were larger than the body sizes of group 2. The body sizes of group 1 developed from the range of 0.687 cm^2–0.868 cm^2 to the range of 1.287 cm^2–2.618 cm^2. At their peaks, the body sizes of the largest tadpoles of both groups had a difference of 0.697 cm^2. The body sizes of group 2 varied between 0.525 cm^2 and 0.823 cm^2 at the beginning of this period on day 27 and between 1.187 cm^2 and 2.744 cm^2 at the end of this period on day 67. From day 67 to day 79, the body sizes of the two groups were similar. Between day 67 and 79, there was only one day at which a tadpole of group 1 clearly had a larger body size which was than the other tadpoles (3.246 cm^2 on day 75). Later on, there was a period between day 80 and day 102 when the body sizes of group 1 were again larger than the body sizes of group 2. The body sizes of group 1 varied between the range of 1.386 cm^2 and 3.589 cm^2 at the beginning of this period and the range of 2.094 cm^2 and 4.545 cm^2 at the end of this period; whereas the body sizes of group 2 varied between the range of 1.147 cm^2 and 2.912 cm^2 at the beginning and the range of 1.726 cm^2 and 3.877 cm^2 at the end of this period.

Between day 103 and day 129 the body sizes of the two groups of tadpoles were similar and the body sizes of some tadpoles of group 2 were larger than those of group 1. The body size span of group 1 varied between 2.017 cm^2 and 4.232 cm^2 at the beginning and between 4.456 cm^2 and 7.339 cm^2 at the end of this period. On day 103 the range of the body sizes of group 2 was between 1.528 cm^2 and 4.271 cm^2. At the end of this time period, the range of the body sizes was between 3.256 cm^2 and 6.178 cm^2. The maximum body size on day 115 had a tadpole of group 2 with 6.181 cm^2. After day 130 the remaining tadpoles of group 1 had larger body sizes than the remaining ones of group 2. At this time, some tadpoles went ashore. The body sizes of group 2 were only collected until day 140, but around this time the body sizes of the tadpoles of group 1 were noticeably larger than the body sizes of group 2, for example, on day 135 the maximum body size of a tadpole of group 1 was 8.094 cm^2, whereas the maximum body size of a

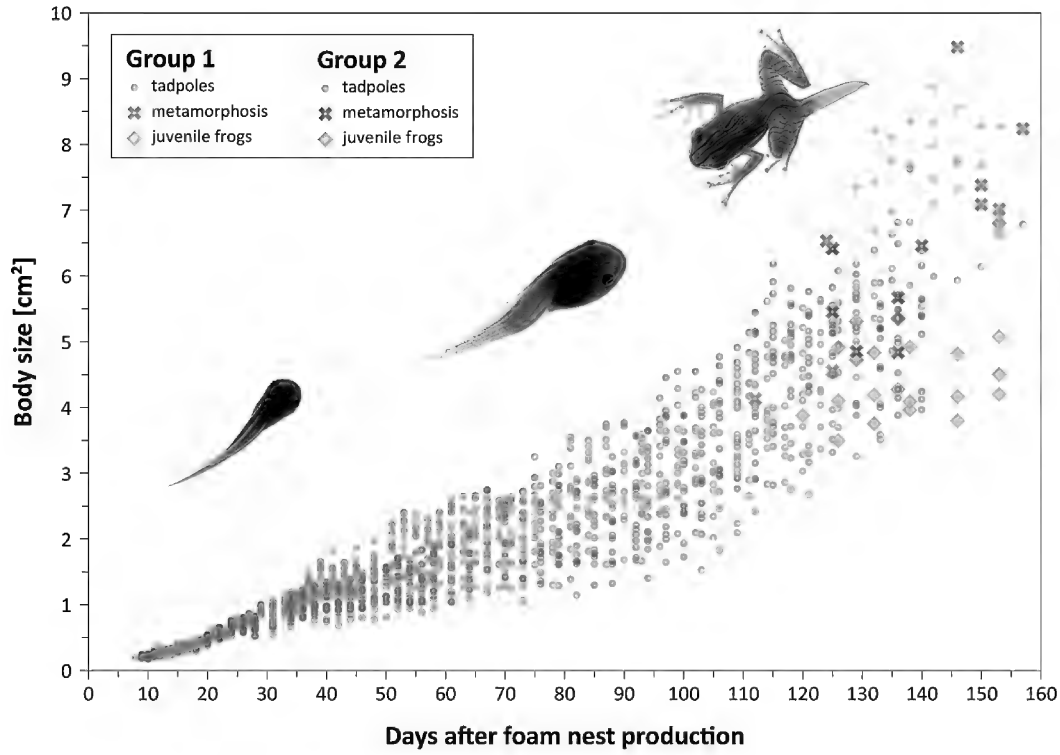

Fig. 6. Comparison of the growth rates of both groups of tadpoles, metamorphs and juvenile frogs.

tadpole of group 2 was 6.811 cm² on day 136. Moreover, the maximum body size of all recorded body sizes had a tadpole of group 1 with 8.864 cm² on day 142. After this day, the body sizes of the tadpoles of group 1 decreased.

Metamorphosis

Froglets entered the landpart between day 112 and day 157. Body sizes ranged from 4.130 to 9.477 cm². The first tadpoles went ashore with a body size of 4.130 cm² and 6.534 cm² on day 112 and 124 (group 1) highlighting a huge difference of the body sizes of the first two tadpoles (Fig. 6). On day 125, three tadpoles went ashore (Fig. 6; two specimens belonging to group 2; 5.450 cm² and 6.413 cm²). Tadpoles of group 1 left the water earlier starting on day 112 than those of group 2 (day 125), while in each cohort the first tadpoles going ashore had smaller body sizes than those which went ashore later.

Mortality and Growth Rate of the Froglets

During the study, no metamorphosed frog died. The first frog which went ashore on day 112 had a body size of 4.130 cm² (Fig. 6), which was reduced to 3.876 cm² on day 120. Two frogs went ashore with body sizes of 5.450 cm² and 6.413 cm² on day 125 and later on day 129, with their body sizes decreasing to 5.307 cm² and 4.723 cm². At this time, their body size span was only at 0.584 cm². The smallest body size had a frog of group 1 with 3.495 cm² on day 126. The three frogs of group 1 had a body size span of 1.419 cm² at the beginning. Moreover, it became evident that all body sizes of these three frogs developed similarly. From day 126 to day 132 the body sizes decreased, whereas the body sizes increased from day 132 to day 138.

DISCUSSION

In comparison to the clutch size of 44 to 119 eggs of *P. otilophus* reported of Tapley and Girgin (2015), the clutch size of 19 and 49 eggs in our study seemed very small. The frogs of our study were sexually mature, but they were apparently not full-grown. Tapley and Girgin (2015) report that three foam nests which were observed by the authors were deposited on leaves and the other eleven clutches were deposited on the glass walls of a vivarium. A similar behaviour of the frogs was evident in our breeding group.

Chakravarty et al. (2011) reported for *Polypedates teraiensis* that this species begins to breed sporadically after the first few rains of the rainy season. Reproduction in our group of *P. otilophus* was also induced by an artificial rainy season. Chakravarty et al. (2011) observed

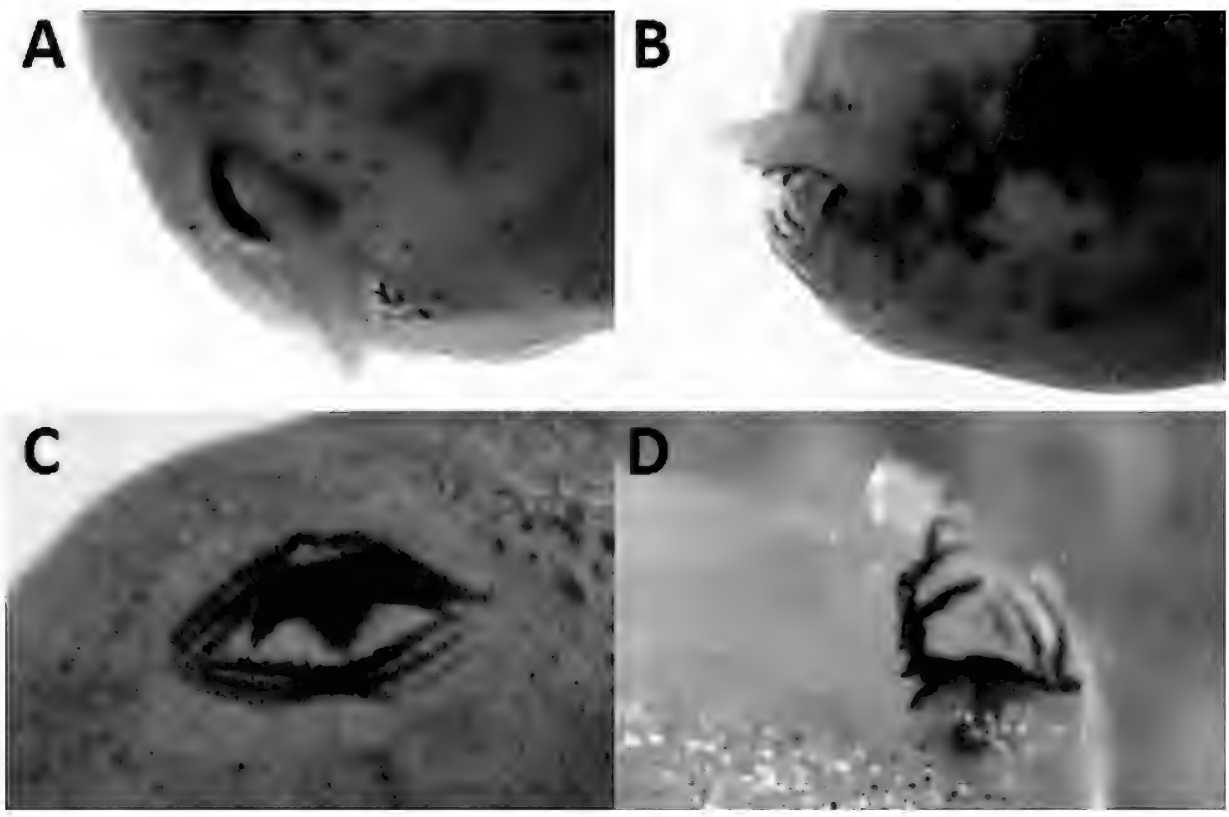

Fig. 7. Enlarged views of the mouths of *Polypedates otilophus* tadpoles from three different perspectives: a tadpole of group 1 on day 15 (A); a tadpole of group 1 on day 16 (B); a tadpole of group 2 on day 20 (C); and a tadpole of group 2 on day 22 (D).

that commonly foam nests were deposited on vegetation above shallow temporary water, but also that some individuals of *P. teraiensis* deposited some foam nests on logs or walls of human habitations far from water, which desiccated and decayed. This behaviour is similar to the just described behaviour of *P. otilophus* depositing eggs on glass walls in captivity.

The large number of eggs found in the foam nest of group 1 was conspicuous, but it is not clear, whether the eggs were unfertilized or whether the tadpoles died during the early development before they could hatch. Yorke (1983) reported for *Polypedates leucomystax* that the embryonic mortality was 34% and that all eggs in all observed foam nests were fertilized. Only two eggs of group 2 did not hatch. One of these two eggs was visible through the glass side from day 8 onwards. Chakravarty et al. (2011) reported for *P. teraiensis* that some eggs which were found on the outermost surface of the foam nest, which may not develop and turned pale yellow due to desiccation. The two eggs of group 2 which were found in the foam nest after the tadpoles hatched were intensively yellow. Moreover, this foam nest was the one which was exposed to drier environmental conditions resulting in a dry and hard consistency. There was a huge difference to the consistency of the foam of group 1 of which the foam nest was regularly sprayed with water. Probably the reason why the tadpoles of group 2 hatched earlier from day 8 to day 10 than those of group 1 which hatched from day 10 to day 14.

Tapley and Girgin (2015) reported that *P. otilophus* tadpoles hatched on about day 10 at a temperature between 22°C and 26°C, but it was not clear whether the ambient temperature was the same where the foam nests were deposited (Tapley & Girgin, 2015). The ambient temperature where the foam nest of group 1 was deposited was about 21.5°C and the temperature where the foam nest of group 2 was placed was about 22°C suggesting constancy in developmental time despite different ambient temperatures.

Gosner (1960) reported that the embryos of most species hatch between the stages 17 to 20. In our study tadpoles of *Polypedates otilophus* dropped into the water at stage 25. Chakravarty et al. (2011) reported for *Polypedates teraiensis* that tadpoles of this species hatched in stage 20 and they dropped into the water in stage 22 suggesting some delay between hatching and leaving the nest. Such a delay may also be present in *P. otilophus*, wherein the trigger of leaving the nest is currently unknown but may be related to rain fall or emerging predators.

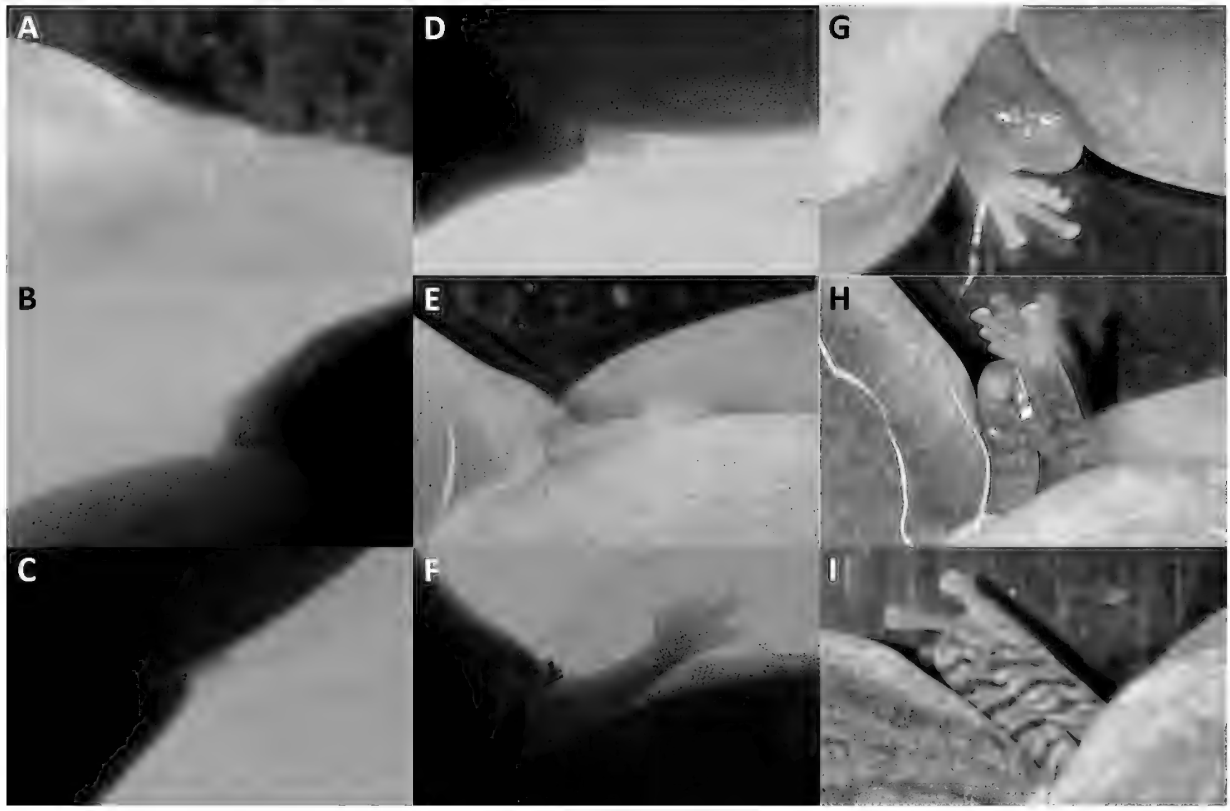

Fig. 8. Development of the hind extremities in *Polypedates otilophus*. Hind limb bud of a tadpole of group 1 in stage 26 on day 21 (A), in stage 28 on day 29 (B), in stage 30 on day 48 (C), in stage 31 on day 51 (D), in stage 36 on day 81 (E), in stage 37 on day 84 with five separated toes (F), in stage 39 on day 96 (G), in stage 39–40 on day 99 (H) and in stage 39–40 on day 105 (I).

In our study tadpoles of *P. otilophus* developed the lower and upper jaw sheaths in stage 25. In contrast to this, the upper and lower jaw sheaths of *P. teraiensis* developed already in stage 22 and the jaw sheaths had completely disappeared in stage 42. The reduction of the jaw sheaths happened in both species at the same time, but the development of the jaw sheaths is earlier in *P. teraiensis* than in other species in which the formations of keratodonts and jaw sheaths are slightly delayed (Chakravarty et al. 2011).

The first tadpoles of group 1 needed 120 days for the entire metamorphosis, whereas the first tadpoles of group 2 completed their metamorphosis after 131 days. This time which the tadpoles needed differs hugely from the period of time which the *P. otilophus* of Tapley and Girgin (2015) required, completing metamorphosis between 74 days and 84 days. They reported only ten days for the complete metamorphosis of the first tadpole and the last metamorphosed tadpole. In our group 1, there was a difference of 49 days between the complete metamorphosis of the first and the last tadpole indicating huge plasticity. One factor could be lower water temperatures, but conditions were largely similar in both studies: Tapley and Girgin (2015) raised their tadpoles at 22°C to 26°C while ours were raised between 19°C and 27°C. Moreover, Tapley and Girgin (2015) reported that their tadpoles were fed daily. In contrast, our tadpoles were fed only three times per week but aditionally fed with dried leaves and algae-covered stones available ad libitum.

The factors food availability and temperature are important ones and strongly affect developmental times. Hsu et al. (2012) reported for *Polypedates braueri* that these tadpoles hybernate if food ressources are limited and, when the ambient temperatures are too low for completing metamorphosis in one year. Furthermore, the authors reported on laboratory experiments in which some tadpoles raised at 15°C never reached metamorphosis (Hsu et al. 2012). These results highlight two points: On the one hand, the development of the tadpoles is influenced by low temperatures so that their development decelerates or is disrupted. On the other hand, the quantity of food is pivotal. These factors could be the reason of the different lengths of the larval phase in our study compared to previous publications. Our two groups were exposed to lower temperatures at a different point of time in their development. That might be the reason why group 2 was behind the development of group 1 at the beginning on day 36, before both groups got a heater. On day 36, it

Fig. 9. Specimens of *Polypedates otilophus* with spinal curvatures: a tadpole of group 1 on day 55 (left) and a tadpole of group 1 on day 124 (right).

was visible that the tadpoles of group 1 had larger body sizes than the tadpoles of group 2. At this point of time, the water temperature of group 1 was only about 19°C. After the heater was in use, the water temperature was not lower than 21°C. Furthermore, group 2 comprised more tadpoles. Maybe, the larger group size has caused a slower development.

In contrast to this hypothesis, Chang et al. (2014) reported for *Rhacophorus moltrechti* that the tadpoles reared under water temperatures of 17°C and 22°C and increased tadpole density, enhanced their larval growth, translating into greater metamorphic mass without changing time to metamorphosis or decreasing survival rates. This process was only reported on the tadpoles which were raised under the just described temperatures. The tadpoles which were raised under a water temperature of 27°C did not show this kind of development (Chang et al. 2014).

Some tadpoles died in group 1, whereas none died in group 2. The first tadpole died on day 18. At this time, tadpoles of group 1 were in stage 25. The next tadpole died on day 109. There is a huge time span during which no tadpole died. Yorke (1983) reported for *Polypedates leucomystax* that the mortality increased between the 31th and 35th day. Moreover, the pooled mortality data showed that 98% of the mortality occurred prior to the tail-bud stage, but in contrast to this, most tadpoles of group 1 died after the tail-bud stages. Some of the tadpoles of group 1 which died had an extremely distinct spinal curvature. Although the species appears to tolerate a broad range of temperature regimes, more studies are necessary to determine the optimal temperature for larval development.

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REFERENCES

Boulenger GA (1893) 4. Descriptions of new reptiles and batrachians obtained in Borneo by Mr. A. Everett and Mr. C. Hose. Proceedings of the Zoological Society of London, 1893: 522–528

Chakravarty P, Bordoloi S, Grosjean S, Ohler A, Borkotoki A (2011) Tadpole morphology and table of developmental stages of *Polypedates teraiensis* (Dubois, 1987). Alytes 27: 85–115

Chang YM, Tseng WH, Chen CC, Huang CH, Chen YF, Hatch KA (2014) Winter breeding and high tadpole densities may benefit the growth and development of tadpoles in a subtropical lowland treefrog. Journal of Zoology 294: 154–160

Frost DR (2017) Amphibian species of the world: an online reference. Version 6.0. Electronic Database accessible at http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York, USA. Accessed 20 Jul 2017

Gosner KL (1960) A simplified table for staging Anuran embryos and larvae with notes on identification. Herpetologica 16: 183–190

Hsu JL, Kam YC, Fellers GM (2012) overwintering tadpoles and loss of fitness correlates in *Polypedates braueri* tadpoles that use artificial pools in a lowland agroecosystem. Herpetologica 68: 184–194

Inger R, Stuebing R, Iskandar D, Mumpuni (2004) *Polypedates otilophus*. The IUCN Red List of Threatened Species. accessible at http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T58962A11862860.en. UK. Accessed at 28 August 2017

Iskandar DT (2004) The amphibians and reptiles of Malinau region, Bulungan research forest, East Kalimantan: annotated checklist with notes on ecological preferences of the species and local utilization. CIFOR, Jakarta

IUCN 2017. The IUCN Red List of Threatened Species. Version 2017-3. http://www.iucnredlist.org. (download: 06 August 2017)

Janzen P (2014) Ohrenfrosch – ein noch wenig bekannter Gast im Terrarium. Reptilia 107: 40–43

Kurth M, Hörnes D, Rödder D (2014) SAISAQ: A novel tool for semiautomatic image based surface area quantification. North-Western Journal of Zoology 10: 217–220

Liem DSS (1970) The morphology, systematics, and evolution of the Old World treefrogs (Rhacophoridae and Hyperoliidae). Fieldiana Zoology 57: vii + 145

Matsui M, Hamidy A, Kuraishi N (2014) A new species of *Polypedates* from Sumatra, Indonesia (Amphibia: Anura). Species Diversity 19: 1–7

Tamuly D, Dey M (2014) Larval morphology and development of tree frog *Polypedates teraiensis* (Dubois, 1987). Current World Environment, Bhopal 9: 182–187

Tapley B, Girgin SM (2015) Captive husbandry and breeding of file-eared tree frogs, *Polypedates otilophus* (Boulenger, 1893) (Amphibia: Anura: Rhacophoridae). The Herpetological Bulletin 132: 5–8

Tschudi JJ (1858) Klassifikation der Batrachier. Mit Berücksichtigung der fossilen Tiere. Reprint 2014 by Dogma Ed., Bremen

Yorke CD (1983) survival of embryos and larvae of the frog *Polypedates leucomystax* in Malaysia. Journal of Herpetology 17: 235–241

APPENDIX I

Appendix 1. Larval development of *Polypedates otilophus* according to the Gosner (1960) stages. Gr. refers to group 1 and 2 respectively, Day refers to the number of days after nest deposition.

Stages	Date [dd.mm.yy]	Day	Characteristic Traits
	Gr. 1: 11.03.2017	14	The eggs are round and brown coloured with a different intensity;
	Gr. 2: 22.03.2017	8	
25	Gr. 1: 08.03.2017	11	The tadpoles dropped into the water; the body of the tadpole was silver coloured underneath the eyes in the lateral view, whereas the body of the tadpole was yellow coloured in dorsal view; the part between the eyes to the tail fin was yellow coloured; the tadpoles were flesh-coloured on the ventral side; the tail fin was transparent with black and silver dots and with a significant visible musculature; the black dots were mainly visible from the transition of the body to the tail fin to two-thirds of the tail fin; variations: the black pigmentation on the whole tail fin; some show a stronger pigmentation on the whole tail fin; mostly the lower as well as the rear tail fin area were free of dots; the number, the order and the size of the dots were individually different; most tadpoles had also black dots around the eyes, on eye level and on the yellow coloured area as well; these dots were also individually variable in size, number and order; the silver dots on the body were on the same area like the black dots, but in comparison to the black dots, the silver dots were visible only above the musculature on the tail fin; body shape was more or less oval in the dorsal view; the body became wider behind the eyes and narrower near the tail like a paunch;
	22.03.2017	8	
25	Gr. 1: 12.03.2017	15	Oral disc with black lower and upper jaw sheaths, black tooth rows developed (Fig. 7A/B);
	Gr. 2: 27.03.2017	13	
25	Gr. 1: 16.03.2017	19	One third of the musculature of the tail fin became thicker (Fig. 5A);
	Gr. 2: 30.03.2017	16	
26	Gr. 1: 18.03.2017	21	Tadpoles developed the hind limb buds (Fig. 8);
	Gr. 2: 03.04.2017	20	
26	Gr. 1: 22.03.2017	25	Tadpoles increased their body weight; the body shape was oval; the body did not become wider beyond the eyes;
	Gr. 2: 05.04.2017	22	
27	Gr. 1: 24.03.2017	27	The hind limb buds increased their growth;
	Gr. 2: 09.04.2017	26	
28	Gr. 1: 26.03.2017	29	The growth of the hind limb buds still went on; the colouring of the tadpoles was still the same;
	Gr. 2: 11.04.2017	28	
29	Gr. 1: 01.04.2017	35	The hind limb buds had approximately 1.5 % size of their diameter;
	Gr. 2: 17.04.2017	34	

Appendix 1. *(continued)*

Stages	Date [dd.mm.yy]	Day	Characteristic Traits
30	Gr. 1: 07.04.2017	41	The hind limb buds grew to the double size of their diameter; the body was silver coloured with black dots around the mouth from the ventral view (Fig. 5B);
	Gr. 2: 23.04.2017	40	
31	Gr. 1: 17.04.2017	51	At this time the first tadpoles reached this stage; the other tadpoles were still in stage 30;
	Gr. 2: 20.05.2017	67	
31	Gr. 1: 21.04.2017	55	Some tadpoles had a light spinal curvature in the transition between the body and the tail fin (Fig. 9A);
31–35	Gr. 2: 26.05.2017	73	
31–35	Gr. 1: 25.04.2017	59	The spinal curvature became more distinctive by the concerned tadpoles of group 1; the tadpoles grew;
	Gr. 2: see stage 37 on 10.06.2017	–	
31–35	Gr. 1: 01.05.2017	65	The spinal curvature became thicker in the concerned tadpoles of group 1;
	–	–	
36	Gr. 1: 17.05.2017	81	All toes with the exception of the first and the second ones were separated; no pigmentation on the hind legs visible; the body shape was rounder;
	Gr. 2: 04.06.2017	82	
37	Gr. 1: 20.05.2017	84	All five toes were separated in one tadpole of group 1 (Fig. 8D); the foot was flesh-coloured with black dots; most tadpoles of group 1 developed a spinal curvature; the spinal curvature became more distinctive in the concerned tadpoles of group 2;
	Gr. 2: 10.06.2017	88	
37–38	Gr. 1: 23.05.2017	87	The hind legs became thicker; it seemed like the hind legs were ruffled; during this time the skin of the hind legs looked transparent so that the underlying skeleton was visible;
	Gr. 2: 22.06.207	100	
37–38	Gr. 1: 26.05.2017	90	The pigmentation on the hind legs increased (Fig. 8F);
	Gr. 2: 25.06.2017	103	
38	Gr. 1: 29.05.2017	93	The inner metatarsal tubercle was formed; the skin on the hind legs still seemed ruffled; moreover, the skin on the hind legs became slowly non-transparent and yellow coloured;
	Gr. 2: 25.06.2017	103	
39	Gr. 1: 01.06.2017	96	The hind legs were non-transparent and yellow coloured;
	Gr. 2: 28.06.2017	106	
39–40	Gr. 1: 04.06.2017	99	The hind legs had a light striation with brownish stripes;
	Gr. 2: 01.07.2017	109	
39–40	Gr. 1: 07.06.2017	102	The hind legs show a significant brown striation; the body has a very light brown striation; the forelimbs are poorly visible under the skin; there was only a light thickening visible where the forelimbs were; the hind legs became larger;
	Gr. 2: 07.07.2017	115	
39–40	Gr. 1: 10.06.2017	105	The brown striation becomes more pronounced on the body;
	Gr. 2: 10.07.2017	118	
41	Gr. 1: 12.06.2017	107	The forelimbs are visible under the skin; the brown striation of the body was significant and the basis of the tail fin also had the brown striation (group 2);
	Gr. 2: 13.07.2017	121	
42	Gr. 1: 14.06.2017	109	Brown striation of the body is significant and the basis of the tail fin shows also a brown striation (group 1); forelimbs protruded;
	Gr. 2: 16.07.2017	124	
43–44	Gr. 1: 16.06.2017	111	The tail fin started to regress; first frogs went ashore; they often held onto the glass walls of the aquarium instead of sitting on the cork;
	Gr. 2: 17.07.2017	125	
45	Gr. 1: 19.06.2017	114	There was only a stub of the original tail fin;
	Gr. 2: 19.07.2017	127	
46	Gr. 1: 25.06.2017	120	The metamorphosis of the first tadpoles was completed;
	Gr. 2: 23.07.2017	131	

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Research article

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Revision of Francis Walker's female types of North American *Rhamphomyia* Meigen (Diptera: Empididae)

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Abstract. Five Nearctic species described by Walker (1849) on the basis of female specimens are revised and illustrated. *Rhamphomyia agasicles* Walker is recognized as a subjective synonym of *R. minytus* Walker and by First Reviser action, the latter is chosen as the senior of the two names. The following additional new synonyms are proposed: *R. dana* Walker, 1849 and *R. valga* Coquillett, 1895 = *R. poplitea* Wahlberg, 1844; and *R. pulla* Loew, 1861 = *R. cophas* Walker, 1849. *Rhamphomyia mallos* Walker could not be associated with any recent specimens and only several old female specimens were found to be conspecific with *R. ecetra* Walker.

Key words. Dance flies, Nearctic, new synonyms.

INTRODUCTION

There are some 210 species of *Rhamphomyia* Meigen, 1822 described from North America (Melander 1965; Poole 1996; Barták 2002; Saigusa 2012), which likely only represents about 25 % of the total diversity in the Nearctic Region. As with most Empidoidea, species concepts are based primarily on differences in the male genitalia and species based on females alone are not easily identified subsequently. The British entomologist, Francis Walker described ten species of *Rhamphomyia*, of which six were unfortunately based solely on female specimens (Walker 1849, 1857). Many of the species described by Walker were collected in subarctic and high boreal Canada (Danks 1981) and deposited in the British Museum insect collection. These species, consisting of notoriously brief descriptions were included in Walker's cataloguing of the thousands of specimens in the museum's collection (see Evenhuis 2018). Smith (1971) revised many of the Nearctic species of Empididae *s. lat.* described by Francis Walker, but was not able to associate males with the six female-based species.

The Canadian National Collection of Insects (CNC) houses vast holdings of empidoids collected worldwide, including the genus *Rhamphomyia*. Building on the efforts of earlier curators, primarily Curran, Shewell and Chillcott (see Cumming et al. 2011), T. Saigusa sorted all available specimens of *Rhamphomyia* to subgenus, species group and species during a four month visit in 1985. In addition, extensive notes and pencil sketches of the male genitalia and male and female legs were made which have permitted identification by subsequent curators and students.

During a study of Canadian Arctic *Rhamphomyia* (Sinclair et al. in prep.), it was decided to study Walker's female *Rhamphomyia* types in order to clarify their identification by associating, if possible, the male sex. The association of males with the female types was accomplished rather rapidly for three of the five species (type of sixth species presumed lost) and is a testament to the quality and breadth of the CNC *Rhamphomyia* collection. The results are discussed below, with each species redescribed and illustrated to facilitate future species identification.

MATERIAL & METHODS

Specimens were borrowed from or housed in the following institutions: BMNH – The Natural History Museum, London; CNC – Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa; MZH – Finnish Museum of Natural History, Helsinki; NHRS – Naturhistoriska Riksmuseet, Stockholm; UGIC – University of Guelph Insect Collection, Guelph; USNM – United States National Museum of Natural History, Washington, D.C. Only five of six Walker types were examined, but all species are listed below.

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Digital images of legs and wings were taken with a Leica camera model DFC425C managed by a Leica Digital Imaging System. Terms used for adult structures follow those of Cumming & Wood (2017).

Label data for primary types are cited from the top downward, with the data from each label in quotation marks. Labels are cited in full, with original spelling, punctuation, and date, and label lines are delimited by a slash (/). Additional information is included in square [ ] brackets. The repository of each type is given in parentheses. Refer to Smith (1971) for explanation of collectors and data labels of the Walker types.

TAXONOMY

Rhamphomyia cophas Walker, 1849
(Figs 1–5)

Rhamphomyia cophas Walker, 1849: 499. Type locality: New York, USA.

Rhamphomyia pulla Loew, 1861: 330. Type locality: Connecticut, USA. **Syn. nov.**

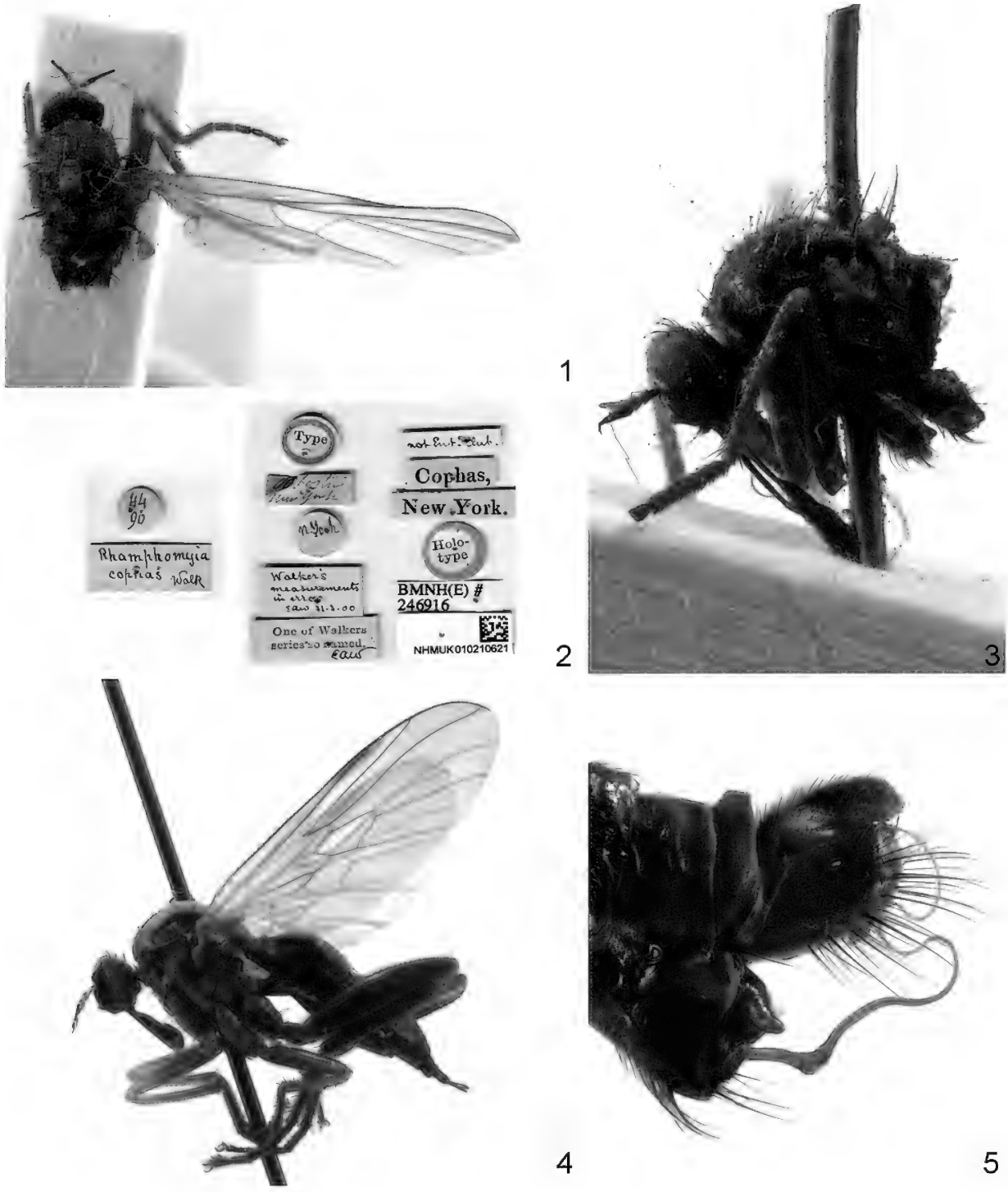
Note about synonymy. Although the holotype of *Rhamphomyia cophas* is in very poor condition (Figs 1, 3), features including leg colouration, body size and mid tibia chaetotaxy allowed for association with identified specimens of *R. pulla*. Although the male holotype of *R. pulla*, housed in the Museum of Comparative Zoology (see: http://140.247.96.247/mcz/Species_record.php?id=1016) possesses yellow femora and tibiae, female legs are much darker in this species, especially the mid and hind legs.

Type material examined. *Rhamphomyia cophas*: **HOLOTYPE** ♀, labelled (Fig. 2): "Type [green margined circle]"; "?? Foster/ New York"; "N.York [on reverse side: 44/ 90"; "Walker's/ measurements/ in error/ EAW 31.3.00"; "One of Walkers/ series so named./ EAW [on reverse side: "Rhamphomyia/ cophas/ Walk.]"; "not Ent. Club."; "Cophas,"; "New York."; "Holo-/ type [red margined circle]; "BMNH(E) #/ 246916"; "NHMUK010210621 [data matrix code]" (BMNH). The holotype is in poor condition, with left midleg, both hind legs, left fore tarsomeres 2–5 and abdomen missing; left wing is slide mounted (see Smith 1971, pl. 2, fig. 7).

Additional material examined. CANADA. Nova Scotia: Cape Breton Highlands NP, Pleasant Bay, 25–29.vi.1984, dry and wet mixed forest, H.J. Teskey (2 ♂♂, 2 ♀♀, CNC). **Ontario:** Coldwater, 20, 30.v.1959, J.G. Chillcott (8 ♂♂, 6 ♀, CNC); Midland, swampy woods, 2, 26.v.1959, J.G. Chillcott (3 ♂♂, 3 ♀♀, CNC); Orillia, 7.vi.1925, 28.vi.1926, 16.vi.1927, C.H. Curran (5 ♂♂, 1 ♀, CNC) (Fig. 4); Osgoode, 22.v.1964, J.R. Vockeroth (1 ♂, CNC); Ottawa, 30.v.1982, J.R. Vockeroth (1 ♂, CNC) (Fig. 5); Simcoe, 2.vi.1939, G.E. Shewell (1 ♂, CNC). **Quebec:** Beach Grove, 7.vi.1965, D.G.F. Cobb (1 ♂, CNC); Duncan Lake, nr. Rupert, 10.vi.1971, J.F. McAlpine (1 ♂, CNC); Gatineau Pk, King Mtn, 45°29′N, 75°51′W, 1.vi.2011, B.J. Sinclair (1 ♂, CNC); Knowlton, 20.vi.1927, G.S. Walley (1 ♂, CNC); Mt. St. Hilaire, 4.vi.1963, J.G. Chillcott (1 ♂, CNC); Norway Bay, 20.vi.1939, E.G. Lester (1 ♂, CNC); Old Chelsea, 12.vi.1964, J.R. Vockeroth (1 ♂, CNC); Rigaud, 11.vi.1981, J.R. Vockeroth (1 ♂, CNC). **UNITED STATES OF AMERICA. Georgia:** Towns Co., Tray Mtn, summit, 26.v.2000, G. & M. Wood (1 ♂, CNC). **Michigan:** Charlevoix Co., 31.v.1960, R. & K. Dreisbach (3 ♂♂, 1 ♀, CNC); Delta Co., 11.vi.1960, R. & K. Dreisbach (1 ♂, 1 ♀, CNC); Gratiot Co., 25.v.1958, R. & K. Dreisbach (2 ♂♂, 1 ♀, CNC); Mackinac Co., 7.vi.1957, 7.vi.1960, R. & K. Dreisbach (1 ♂, 4 ♀, CNC); Mecosta Co., 15.vi.1957, R. & K. Dreisbach (1 ♂, 1 ♀, CNC); Missaukee Co., 31.v.1957, R. & K. Dreisbach (1 ♂, 1 ♀, CNC); Ontonogan Co., 18.vi.1960, R. & K. Dreisbach (3 ♂♂, 1 ♀, CNC); Roscommon Co., 31.v.1957, R. & K. Dreisbach (1 ♂, 1 ♀, CNC). **New York:** McLean Reserve, nr. Dryden, 11.vi.1964, J.G. Chillcott (1 ♂, 2 ♀♀, CNC). **North Carolina:** Great Smoky Mtns NP, Noland Divide Tr., 1700 m, 35°33′58″N, 83°28′37″W, 4.vi.2001, J.M. Cumming (2 ♂♂, CNC). **Ohio:** Hocking Co., Coovert Reserve, 19.v.2003, hollow, J.M. Cumming (2 ♂♂, CNC).

Diagnosis. Males of this species are distinguished by the dark abdomen, yellow femora and tibiae, with at least apex of hind tibia darkened; scape and pedicel yellowish; and upper digitiform process of sternite 7 projecting horizontally, lower process hook-like, arched dorsally; phallus with lower loop rectangularly curved and ridged expansion only slightly broader than shaft of phallus. Female have a darkened, shiny abdomen, mid and hind femora dark with yellowish tip and fore femur mostly dark with apical half yellowish.

Redescription. Wing length 6.2–7.4 mm. **Male.** Head dark in ground-colour, with greyish pruinescence on face, frons, postgena and occiput; oral margin shiny reddish. Holoptic, eyes with ommatidia very slightly larger on upper half of eye. Frons divergent towards antennal sockets, bare. Margins of face slightly divergent. Ocellar triangle with pair of slender ocellar setae, longer than postocular setae. Upper half of occiput bearing row of stout postocular setae, stouter than ocellar setae; lower postocular setae mostly slender and longer. Occipital setae black and stout. Antenna with scape, pedicel and extreme base of postpedicel yellow; postpedicel mostly dark, nearly 4× longer than basal width; stylus length subequal to basal width of postpedicel. Palpus yellow, bearing long, slender setae. Clypeus bare, reddish and



Figs 1–5. *Rhamphomyia cophas* Walker. **1.** Holotype, female, dorsal view; **2.** Holotype labels; **3.** Holotype, lateral view; **4.** Recent specimen, female, lateral view; **5.** Male terminalia, lateral view. See Additional material examined section for locality details of recent specimens.

glossy; labrum dark and glossy, longer than eye height; labellum dark and bearing many fine setae.

Thorax dark with dense grey pruinescence; brown to black vittae beneath acrostichal and dorsocentral rows extending to prescutellar depression; posterior corner of postpronotal lobe and postalar ridge yellowish brown. Pleura with yellowish brown highlights about suture lines. Prosternum bare; proepisternum at fusion point with prosternum with several dark setae; upper part of proepisternum in front of anterior spiracle bare. Antepronotum with dense row of long, stout setae. Postpronotal lobe with 1 outstanding seta and 8 or more shorter setae of various thicknesses; acrostichal setae uniserial, two-thirds length of dorsocentral setae; dorsocentral setae uniserial, increasing in length posteriorly, prescutellar seta longer than lateral scutellar seta; 1 presutural supra-alar seta (= posthumeral), with several surrounding fine setulae; 3–4 notopleural setae, with several fine setulae anteriorly; 0 prealar setae; 1 postsutural supra-alar seta; 1 postalar seta and several shorter setae; 1 long apical pair and shorter lateral pair of marginal scutellar setae. Laterotergite with cluster of long, dark setae. Anterior and posterior spiracles blackish brown.

Legs long, stout; femora and tibiae yellow, apex of hind tibia often brown; coxae brown becoming yellowish apically. Coxae with lateral row of black setae. Femora with dense white ventral pile. Fore femur with row of anteroventral and posteroventral setae increasing in length apically. Fore tibia with long, pale ventral pubescence; 2–3 anterodorsal and posterodorsal setae; apex with several dark setae. Mid femur with anteroventral and posteroventral rows of short, even-length stout setae; 1 dark anterior preapical seta. Mid tibia with anteroventral and posteroventral row of short stout setae; 2–3 anterodorsal and posterodorsal setae. Hind femur longer and stouter compared to other femora; anteroventral row of short stout setae increasingly closer together distally; two rows of 3–5 stout anterior setae on apical third. Hind tibia with long, ventral pubescence; 5–6 black anterodorsal and posterodorsal setae, shorter than width of tibia; apex with several dark setae; 1 long seta in posteroapical comb. Tarsomere 1 of all legs slender; ventral margin of all tarsomeres with dense ventral pile; hind tarsomeres with several pairs of spine-like ventral setae.

Wing lightly infuscate; pterostigma elongate, distinct; basal costal seta present. Cell dm shorter than cell bm; CuA+CuP complete, reaching wing margin without weakening; alular incision acute; margin of calypter with dark setae. Halter with whitish knob and yellowish stalk.

Abdomen dark brown, basal segment and tergites 7 and 8 with whitish pruinescence, remaining segments shiny; setae pale brown, lateromarginal setae on segments 2 and 3 long, stouter and darker. Sternites 2–6 with pair of very long, divergent median marginal setae, nearly as long as length of sclerite. Tergite 7 similar in width to tergite 6. Sternite 7 tapered apically to truncate margin, with 2 rows of long stout setae, becoming longer posteriorly; posterolateral margin expanded into cup-like process, bearing pair of short digitiform processes: upper process short, horizontally projected; lower process hook-like, arched dorsally. Tergite 8 more thickly sclerotized than tergite 7, expanded laterally at mid-length, fused to sternite. Sternite 8 slender, compressed between expanded posterolateral margins of sternite 7; bearing long, stout setae. Terminalia (Fig. 5) dark brown, phallus pale brown. Hypandrium slender, strap-like, wrapping around base of phallus. Epandrium subrectangular, with rounded apex; posterior half clothed in long, stout setae; slightly longer than length of cercus. Subepandrial lobe lacking; bacilliform sclerite with dense, erect short setae. Cercus subrectangular with rounded apex; dorsal margin with triangular medial lobe at mid-length. Phallus slender with two deep loops, with lower loop rectangularly curved; sharply bent at mid-length at point of ridged expansion; expansion only slightly broader than shaft of phallus. Ejaculatory apodeme narrow, subtriangular; horizontal lamella on ventral margin.

Female. Similar to male except (Fig. 4): frons with greyish pruinescence, glossy medially; margin with row of setae, uppermost shorter. Acrostichal row initially uniserial, biserial on posterior half. Mid and hind femora dark with yellowish tip and fore femur mostly dark with apical half yellowish; hind femur inflated, broader than other femora; femora without ventral pile. Abdomen mostly shiny, except for apical segments; setae pale, except pair of dark, divergent setae on sternites 2–5; dark, pilose pleural membrane, indicating retracted pleural sacs. Cercus long and slender, length 4–5 times width.

Geographic distribution. This species is widespread in eastern North America, ranging from northern Ontario (Canada), south to North Carolina and Georgia (USA) and as far west as Michigan.

Remarks. Although the holotype of *R. cophas* is in poor condition, very greasy with abdomen and most of the legs missing, it can be readily assigned to the subgenus *Calorhamphomyia* Saigusa, 1963 on the basis of lustrous clypeus, leg colouration, thoracic chaetotaxy (prealar setae absent) and general body size. Saigusa (1963) assigned *R. pulla* to this subgenus.

Rhamphomyia ecetra Walker, 1849
(Figs 6–10)

Rhamphomyia ecetra Walker, 1849: 500. Type locality: Georgia, USA.

Type material examined. *Rhamphomyia ecetra*: **HOLOTYPE** ♀, labelled (Fig. 8): "Type [green margined circle]"; "One of Walkers/ series so named./ EAW [on reverse side: "Rhamphomyia/ ecetra/ Walk.]";

Figs 6–10. *Rhamphomyia ecetra* Walker. **6.** Holotype, female, dorsolateral view; **7.** Recent specimen, female antenna, lateral view; **8.** Holotype labels, left label underside of corresponding label in centre row; **9.** Recent specimen, female, lateral view; **10.** Recent specimen, female, anterior view. See Additional material examined section for locality details of recent specimens.

"Ecetra,"; "Georgia."; "Pararhamphomyia"; "Holo- / type [red margined circle]; "BMNH(E) #/ 246919"; "NHMUK010210624 [data matrix code]" (BMNH). The holotype is missing both hind tibia and tarsus, right fore tibia and tarsi and left wing is slide mounted (see Smith 1971, pl 3, fig. 1).

Additional material examined. UNITED STATES OF AMERICA. Georgia (3 ♀♀, USNM). **North Carolina:** Morrison (3 ♀♀, USNM) (Figs 7, 9, 10).

Diagnosis. Females of this species are distinguished by the dense presutural supra-alar setae; 3 pairs of scutellar setae; dark legs with dorsal and ventral pennate setae on hind femur and tibia, mid femur and tibia and fore tibia, and dorsally only on fore and mid basitarsus; abdomen shiny with reddish margins; cell dm short, distinctive shape, shorter than cell bm; basal costal seta present.

Redescription. Wing length 4.1–4.6 mm. **Female.** Head dark in ground-colour, with greyish pruinescence on face, frons, postgena and occiput; oral margin shiny reddish. Dichoptic, ommatidia even-sized throughout. Frons and face broad, subequal in width; frons with row of setulae along eye margin (Fig. 7). Ocellar triangle with pair of long ocellar setae, longer than postocular setae. Upper half of occiput bearing row of stout postocular setae, stouter than ocellar setae; lower postocular setae brown, paler than upper setae, slender and shorter. Occipital setae black and stout; postgenal setae paler than occipital setae, long and slender. Antenna brown; scape longer than pedicel; postpedicel nearly 3× longer than basal width (Fig. 7); stylus length about equal to length of scape. Palpus dark, slender, bearing numerous long, dark setae. Clypeus bare, with greyish pruinescence; labrum dark and glossy, nearly 1.5 times longer than eye height; labellum dark and bearing many pale setae, longer than palpal setae.

Thorax dark with dense grey pruinescence; greyish-white vittae between acrostichal and dorsocentral rows; dark vittae beneath acrostichal and dorsocentral rows extending to prescutellar depression; posterior corner of postpronotal lobe and postalar ridge brownish. Prosternum bare; proepisternum at fusion point with prosternum with several long, slender setae; upper part of proepisternum in front of anterior spiracle bare. Antepronotum with dense row of stout setae. Postpronotal lobe with 1–2 outstanding setae, clothed in numerous long, slender setae; acrostichal setae biserial, subequal in length to dorsocentral setae (Fig. 10); dorsocentral setae multiserial, increasing in length posteriorly, prescutellar seta slightly shorter than lateral scutellar seta; presutural supra-alar clothed with numerous slender setae, similar to dorsocentral setae, occasionally with 1–2 outstanding setae (posthumeral); numerous long, slender anterior notopleural setae, similar to presutural supra-alars; 3–4 stronger posterior notopleural setae; 2–3 prealar setae and 1 postsutural supra-alar seta, with numerous shorter setae; 1 postalar seta; 1 long apical pair and 2 shorter lateral pairs of marginal scutellar setae. Laterotergite with cluster of long, dark setae. Anterior and posterior spiracles brownish.

Legs short, slender, brown with grey pruinescence on coxae. Fore coxa with row of long slender anterolateral setae; lateral regions of mid and hind coxae with similar setae. Fore femur with row of fine anteroventral setae, shorter than width of femur. Fore tibia densely clothed in setae, dorsal setae pennate, subequal in length to width of tibia; ventral setae slightly pennate, shorter than width of tibia; apex with several stout subapical setae. Mid femur with dense white ventral pile; anteroventral row of short, even-length setae; posteroventral row of pennate setae nearly as long as width of femur; dorsal setae slightly pennate. Mid tibia with anterodorsal and posteroventral row of pennate setae; 1 stout anterodorsal seta at mid-length and several subapical setae. Hind femur (Fig. 9) with dense white ventral pile; dorsal margin with pennate setae; posteroventral row of pennate setae longer than dorsal row; anteroventral row of setae short and slender. Hind tibia with dorsal and ventral pennate setae, shorter than width of tibia; 3–4 anterodorsal and posterodorsal setae; 1 long seta in posteroapical comb. Tarsomere 1 of fore and mid legs with short dorsal pennate setae; hind leg with 3–4 stout anterodorsal and posterodorsal setae, longer than tarsomere; 3–4 stout anteroventral and posteroventral setae, subequal to width of tarsomere.

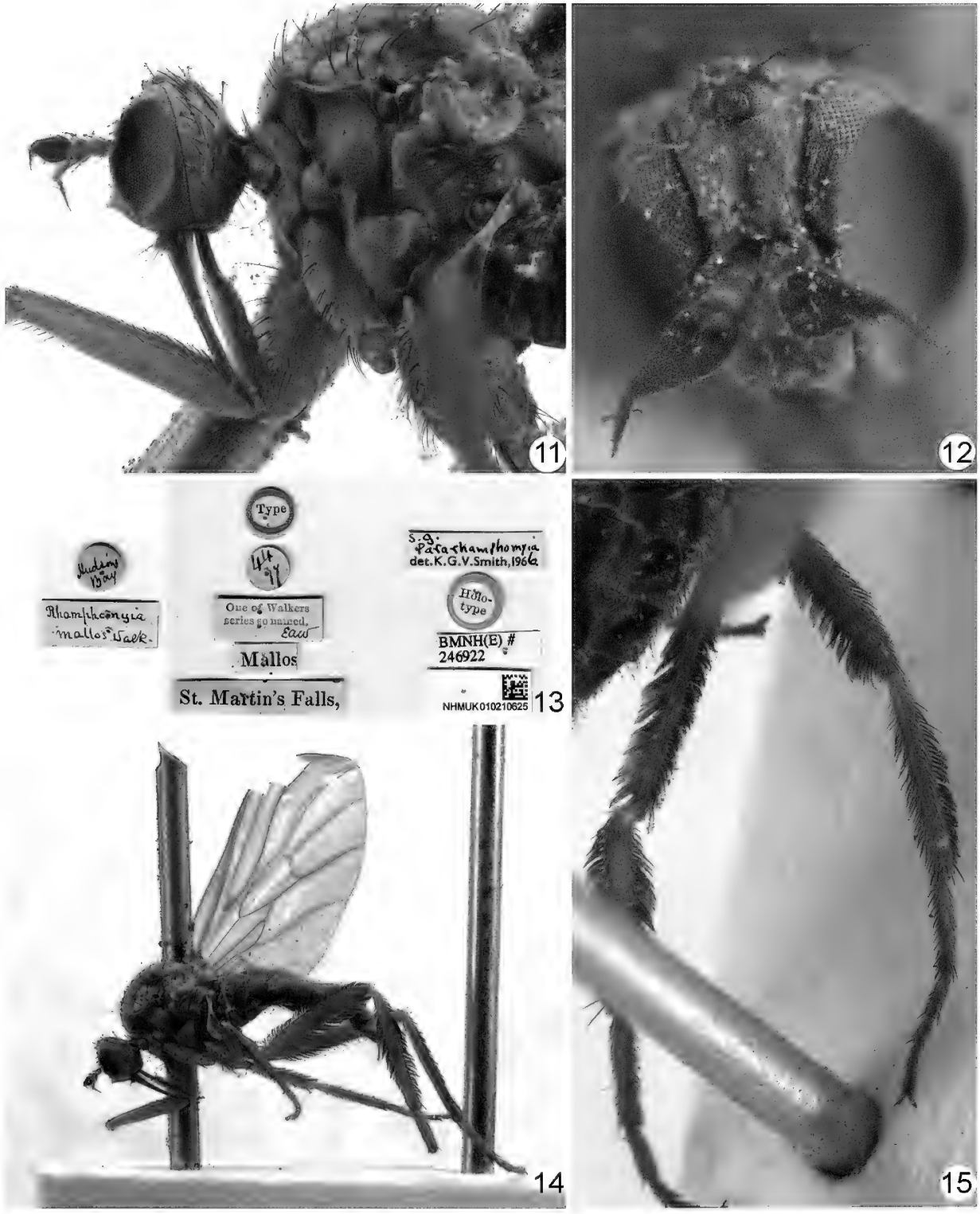
Wing infuscate; pterostigma elongate, distinct; long basal costal seta present. Cell dm shorter than length of cell bm (Fig. 9); CuA+CuP reaching wing margin with weakening at mid-length; alular incision acute; margin of calypter with long brown setae. Halter brown.

Abdomen shiny with reddish lateral margins and dark posterior margins; setae dark and numerous. Cercus long and slender, with fine setae.

Male. Unknown.

Geographic distribution. This species is possibly restricted to the southern Appalachian Mountains of Georgia and North Carolina (USA).

Remarks. *Rhamphomyia ecetra* is assigned to the *R.* (*Pararhamphomyia*) *plumifera* group *sensu* Saigusa (unpubl. data) (or perhaps *R. obscura* group *sensu* Barták & Kubík 2009) and appears very similar to the species complex of *R. brevis* Loew, 1861/*R. corvina* Loew, 1861. *Rhamphomyia ecetra* is characterized by three pairs of scutellar setae and most specimens of the *brevis*/*corvina* complex have two pairs of scutellar setae. Males from Georgia are required to make further conclusions concerning the identification of this species.



Figs 11–15. *Rhamphomyia mallos* Walker. **11.** Holotype, female, fore femur, head, lateral view; **12.** Holotype, antenna, head, anterior view; **13.** Holotype labels, left two labels underside of corresponding labels in centre row; **14.** Holotype, lateral view; **15.** Hind leg, posterior view.

***Rhamphomyia mallos* Walker, 1849**
(Figs 11–15)

Rhamphomyia mallos Walker, 1849: 502. Type locality: St. Martin's Falls [Ogoki], Albany River, Ontario, Canada.

Type material examined. *Rhamphomyia mallos*: **HOLOTYPE** ♀, labelled (Fig. 13): "Type [green margined circle]"; "44/ ?? [underside: Hudson's/ Bay]"; "One of Walkers/ series so named./ EAW [on reverse side: "Rhamphomyia/ mallos/ Walk.]"; "Mallos,"; "St. Martin's Falls,"; "s.g./ Pararhamphomyia/ det. K.G.V. Smith, 1966"; "Holo-/ type [red margined circle]; "BMNH(E) #/ 246922"; "NHMUK010210625 [data matrix code]" (BMNH). Holotype is missing the left foreleg, fore tibia and tarsi and left hind tarsomere 2–5; the left wing is slide mounted (see Smith 1971, pl. 3, fig. 2).

Diagnosis. The holotype female is characterized by pale legs, bare prosternum, pennate setae on mid- and hind-legs and thickened setae dorsally on fore femur; postpedicel short, rounded basally; abdomen with pennate setae laterally on segments 3 and 4 (on pleura?).

Redescription. Wing length 7.3 mm. **Female.** Head dark in ground-colour, with greyish pruinescence on face, frons, postgena and occiput; oral margin pruinescent. Dichoptic, ommatidia with uppermost smaller. Frons and face broad, subequal in width; frons with row of setulae along eye margin, uppermost shorter. Ocellar triangle with pair of ocellar setae. Upper half of occiput bearing row of stout postocular setae; lower postocular setae slender and shorter. Occipital setae black and stout; postgenal setae long and slender. Antenna (Fig. 12) with scape and pedicel pale brown, postpedicel darker; scape 1.5 times longer than pedicel; postpedicel with broad base, 4 times longer than pedicel; stylus greater than half length of postpedicel. Palpus yellowish brown, slender, bearing numerous long, dark setae. Clypeus not visible; labrum dark and glossy, nearly 1.3 times longer than eye height (Fig. 11); labellum dark and bearing many long, dark setae.

Thorax dark with dense grey pruinescence; brownish vittae beneath acrostichal and dorsocentral rows; lateral scutum with apparent brownish ring encircling base of major setae; posterior corner of postpronotal lobe and postalar ridge brownish. Prosternum bare; proepisternum at fusion point with prosternum with 3 long, slender setae; upper part of proepisternum in front of anterior spiracle bare. Antepronotum with row of stout setae. Postpronotal lobe with 1 outstanding seta, clothed in numerous long and short, slender setae; acrostichal setae biserial, subequal in length to dorsocentral setae; dorsocentral setae uniserial, biserial anteriorly, prescutellar seta subequal in length to scutellar setae; dorsocentral row curved towards postpronotal lobe anteriorly; 3 presutural supra-alar setae (posthumeral) and 2 posterior presutural supra-alar setae; 4–5 anterior notopleural setae and 3 posterior notopleural setae in oblique row; 3–4 prealar setae; 1 postsutural supra-alar setae; 1 postalar seta; 2 pairs of marginal scutellar setae. Laterotergite with cluster of long, dark setae. Anterior and posterior spiracles yellowish brown, concolourous with halter.

Legs long, pale or yellowish brown with very thin grey pruinescence on coxae. Fore coxa with row of long slender anterolateral setae; lateral region of mid and hind coxae with similar setae. Fore femur with row of anteroventral and posteroventral setae; stronger anterodorsal setae on basal third. Fore tibia lost. Mid femur with anteroventral row of short, even-length setae, longer near base; posteroventral row of pennate setae nearly half length of femur width; anterodorsal setae narrowly pennate, slightly shorter than setae of posteroventral row. Mid tibia with anterodorsal and posteroventral row of pennate setae; row of anteroventral setae short. Hind femur with row of anterodorsal and posteroventral pennate setae (Fig. 15); setae of anteroventral row short and slender. Hind tibia with row of anterodorsal and posteroventral pennate setae, shorter than width of tibia; 5–6 posterodorsal setae; 1 long seta in posteroapical comb. Tarsomere 1 of all legs without pennate setae.

Wing infuscate, especially along veins (Fig. 14); pterostigma elongate, distinct; basal costal seta absent. Cell dm slightly shorter than length of cell bm; CuA+CuP reaching wing margin with weakening at mid-length; alular incision nearly right angled; calypter with dark setae. Halter yellowish brown.

Abdomen dark brown with black setae; pennate setae laterally on segments 3 and 4. Cercus long and slender, with fine setae.

Male. Unknown.

Geographic distribution. The label data is likely incorrect (see Remarks) and this species is possibly found in southeastern North America.

Remarks. *Rhamphomyia mallos* initially appeared very similar to *R.* (*Dasyrhamphomyia*) *villipes* Coquillett, 1900 on the basis of pennate setae on legs and large size, but the latter species has more setae on the fore femur, proboscis distinctly longer, postpedicel elongate and without abdominal pennate setae. No specimens could be found that matched the distinctive combination of features of this female, especially the abdominal pennate setae. It is doubtful such a large sized species from northern Ontario would be absent from the CNC, which could indicate that the specimen is mislabelled and possibly originates from the southeastern United States of America. Expanding the search, we found that *R. mallos* is rather similar to *R. testacea* Loew, 1862, with reduced setae on the fore femur and broad postpedicel, but the length

of the pennate setae of the latter species is longer than the width of corresponding leg segment (see MCZ type collection: http://140.247.96.247/mcz/Species_record.php?id=13637). There is also an undescribed brownish species in the CNC from Virginia, Tennessee, Arkansas and possibly Mississippi and Texas, where the females possess abdominal pennate setae, very similar shaped postpedicel and very long pennate setae on all legs. The latter species is currently assigned to a group of species similar to *R. pectinata* Loew, 1861. Unfortunately all these species differ from *R. mallos* in antennal colour, thoracic chaetotaxy and length of the pennate setae on the legs.

Rhamphomyia minytus Walker, 1849

(Figs 16–20)

Rhamphomyia minytus Walker, 1849: 502. Type locality: St. Martin's Falls [Ogoki], Albany River, Ontario, Canada.

Rhamphomyia agasicles Walker, 1849: 499. Type locality: St. Martin's Falls [Ogoki], Albany River, Ontario, Canada. **Syn. nov.**

Note about synonymy. *Rhamphomyia minytus* and *R. agasicles* were described in the same paper by Walker (1849). We consider these names to be subjective synonyms, with the former based on a male and the latter on a female of the same species. Acting as the First Reviser, we select *R. minytus* as the senior synonym (Article 24.2.2 of the Code, ICZN 1999).

The shiny scutum, anepisternum and abdomen and the broadened hind tarsomere 1 allowed for the association of the sexes. The illustrations of the male terminalia and hind tarsi by Smith (1971, figs 13, 14) facilitated identification of additional males specimens and direct examination of the male holotype of *R. minytus* was un-necessary.

Type material examined. *Rhamphomyia agasicles*: **LECTOTYPE** ♀, labelled (Fig. 18): "Type [green margined circle]"; "One of Walkers/ series so named./ EAW [on reverse side: "Rhamphomyia/ agasicles/ Walk.]"; "Agasciles,"; "St. Martin's Falls,"; "LECTO-/ TYPE [blue margined circle]; "Pararhamphomyia [written by Smith]"; "BMNH(E) #/ 246915"; "NHMUK010210622 [data matrix code]" (BMNH). The lectotype is in good condition, with the left wing slide mounted (see Smith 1971, pl. 2, fig. 6).

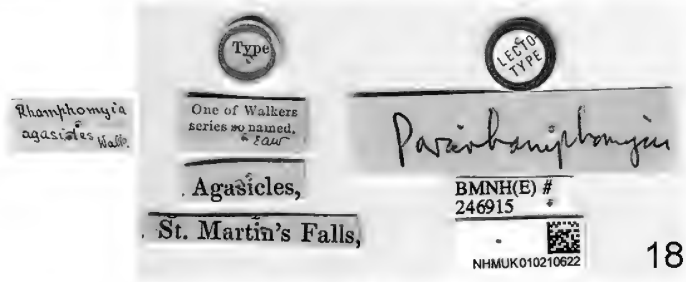
Additional material examined. CANADA. British Columbia: Alaska Hwy, mi 392, Summit Lake, 4500 ft, 2–4.vii.1959, E.E. MacDougall (1 ♀, CNC); same locality, 5300 ft, 18.vi.1959, R.E. Leech (1 ♀, CNC) (Fig. 19); same locality, 5000 ft, 23.vi.1959, R.E. Leech (1 ♂, CNC) (Figs 17, 20); same locality, 4500 ft, 23–24.vi.1959, R.E. Leech (1 ♀, CNC).

Diagnosis. Females of this species are distinguished by the shiny scutum, anepisternum and abdomen; hind femur with short posterodorsal pennate setae; hind tibia with short anteroventral setae; hind tarsomere 1 as broad as apex of hind tibia; wings broad, darkly infuscate with pale base. Males are distinguished by the broad and setose hind tarsomere 1; base of hind tibia with cluster of posterior setae; cercus and epandrium narrow and elongate with base of both shiny.

Redescription. Wing length 3.5–3.8 mm. **Male.** Head dark in ground-colour, with greyish pruinescence on face, frons, postgena and occiput; oral margin shiny reddish. Holoptic, eyes with ommatidia larger on upper half of eye, smaller on lower half. Frons divergent towards antennal sockets, bare. Margins of face slightly divergent; greyish pruinescence laterally, glossy medially. Ocellar triangle shiny with pair of ocellar setae, shorter than postocular setae. Occipital setae posterior to ocellar triangle stouter than postocular setae. Postocular setae long and slender; postgenal setae similar to postoculars. Antenna dark; scape slightly longer than pedicel; postpedicel nearly 3× longer than basal width; stylus length about half length of scape. Palpus dark, slender, bearing several long, subapical setae. Clypeus bare and glossy; labrum dark and glossy, slightly longer than eye height; labellum dark and bearing many dark setae, subequal or longer than palpal setae.

Thorax dark brown with dense grey pruinescence; anepisternum shiny; dorsum of scutum shiny, with anterior face of postpronotal lobe and lateral margin from notopleuron to scutellum and prescutellar depression pruinescent. Prosternum bare; proepisternum at fusion point with prosternum with several setae; upper part of proepisternum in front of anterior spiracle bare. Antepronotum with row of stiff setae. Postpronotal lobe with 1 outstanding seta and several shorter, finer setae; acrostichals biserial, slightly shorter than dorsocentral setae; dorsocentrals biserial to prescutellar depression, increasing in length posteriorly, uniserial prescutellar setae shorter than apical scutellar setae, dorsocentral row curved towards postpronotal lobe anteriorly; 1 presutural supra-alar seta (posthumeral) and several shorter setulae; 3 notopleural setae, with several setulae; 0 prealar setae; 1 postsutural supra-alar seta; 1 postalar seta; 1 long apical pair and short lateral pair of marginal scutellar setae. Laterotergite with cluster of long, dark setae. Anterior and posterior spiracles concolourous with pleura.

Legs dark brown, somewhat shiny. Fore coxa with row of 5–6 stiff anterolateral setae; lateral regions of mid and hind coxae with similar setae. Fore femur with row of fine posteroventral setae. Fore tibia with several rows of dorsal setae, longer than width of tibia; posterior



Figs 16–20. *Rhamphomyia minytus* Walker. **16.** Lectotype of *R. agasicles* Walker, female, dorsolateral view; **17.** Recent specimen, male terminalia, lateral view; **18.** Lectotype of *R. agasicles* Walker, labels, left label underside of corresponding label in centre row; **19.** Recent specimen, female, lateral view; **20.** Recent specimen, male hind leg, anterior view. See Additional material examined section for locality details of recent specimens.

face clothed with fine short setae. Mid femur with anteroventral and posteroventral rows of stout setae, longer than width of femur. Mid tibia clothed with stout ventral setae, shorter than width of tibia. Hind femur (Fig. 4E) slightly twisted medially on apical third; basal half with row of posterior setae, subequal to width of femur; apical third with row of posterodorsal setae increasing in length apically. Hind tibia straight, with anterodorsal setae, increasing in length and stouter apically; base of hind tibia with cluster of posterior setae; 1 long seta in posteroapical comb. Hind tarsomere 1 greatly expanded and flattened, broader than tibia (Fig. 20), with dense dorsal setae, longer than width of segment; tarsomeres 2 and 3 somewhat swollen with long dorsal setae.

Wing lightly infuscate; pterostigma elongate, lightly infuscate; without basal costal seta. Cell dm subequal in length to cell bm; CuA+CuP weak, reaching wing margin as crease; alular incision right angled; margin of calypter with brown setae. Halter pale yellowish brown.

Abdomen dark brown, shiny, with longer ventral setae; dorsolateral setae pale brown. Tergite 8 reduced to half-length of sternite; sternite 8 with short rounded posterior margin bearing long setae, longer than length of sclerite. Terminalia (Fig. 17) dark brown (undissected). Epandrium elongate, slightly constricted beyond middle, bearing many fine setae, longer along ventral margin and apically; middle outer face with dense setae; lower basal half polished. Cercus elongate, 3/4 length of epandrium; expanded beyond mid-length; polished on basal half; dorsal margin at base bearing many short, fine setae; inner surface on apical half with numerous slender setae. Phallus filamentous, with slight inward curve towards middle, forming loop extending beyond epandrium and recurved between cerci; ejaculatory apodeme and hypandrium not examined in undissected specimen.

Female. Similar to male except frons shiny with pale lateral setulae, with greyish pruinescence above antennae; hind femur with short posterodorsal pennate setae, hind tibia with short anteroventral setae; hind tarsomere 1 as broad as apex of hind tibia (Fig. 16); wings broader than male, darkly infuscate with pale base (Fig. 19).

Geographical distribution. This species is known from northern British Columbia and northern Ontario (Canada).

Remarks. *Rhamphomyia minytus* is assigned to the *R.* (*Pararhamphomyia*) *caudata* (Zetterstedt, 1838) group, and in North America this species group also includes *R. priapulus* Loew, 1861 and *R. ursinella* Melander, 1928 and several undescribed species.

***Rhamphomyia poplitea* Wahlberg, 1844**
(Figs 21–28)

Rhamphomyia poplitea Wahlberg, 1844: 107. Type locality: Quickjock, Sweden.
Rhamphomyia dana Walker, 1849: 502. Type locality: St. Martin's Falls [Ogoki], Albany River, Ontario, Canada. **Syn. nov.**
Rhamphomyia valga Coquillett, 1895: 428. Type locality: New Hampshire, USA. **Syn. nov.**

Note about synonymy. Females of this species are rather distinctive on the basis of the very long pennate setae (Figs 23–24, 27) and *R. dana* matched females identified by Chillcott (1959) as *R. valga*. *Rhamphomyia valga* is assigned to the *R. basalis* Loew, 1864 group defined on the basis of the highly modified male hind leg (Chillcott 1959). All species of the *R. basalis* group were examined in detailed in both the USNM and CNC and in combination with the key to females in Chillcott (1959) only one species (*R. valga*) matched the female Walker type.

Following the initial identification of *R. dana* with *R. valga*, it was learned that the European species, *R. poplitea* should also be assigned to the *R. basalis* group. Only digital images of the holotype of *R. poplitea* were studied. On the basis of identical colour of the abdomen, shape of the male hind leg and male terminalia *R. valga* is considered a synonym of *R. poplitea*.

Type material examined. *Rhamphomyia dana*: **HOLOTYPE** ♀, labelled (Fig. 25): "Type [green margined circle]"; "One of Walkers/ series so named./ EAW [on reverse side: "Rhamphomyia/ dana/ Walk.]"; "Dana,"; "St. Martin's Falls,"; "Pararhamphomyia/ det. K.G.V. Smith, 1968"; "Holo-/ type [red margined circle]; "BMNH(E) #/ 246917"; "NHMUK010210623 [data matrix code]" (BMNH). The holotype is in good condition, with right postpedicel missing and left wing slide mounted (see Smith 1971, pl. 2, fig. 8).

Rhamphomyia poplitea: **HOLOTYPE** ♂, labelled (Fig. 22): "Lp./ in. [Lapponia interior]"; "Bhn [Boheman collection]"; "Typus"; "poplitea, Wahlb. [unit tray label]" (NHRS).

Rhamphomyia valga: **HOLOTYPE** ♂, labelled: "White Mts./ Morrison."; "Collection/ C.V. Riley"; "Type/ No. 3217/ U.S.N.M. [red label]"; "Rhamphomyia/ valga/ Coq." (USNM).

Additional material examined. CANADA. New Brunswick: Kouchibouguac NP, 5–14.vii.1977, J.R. Vockeroth, G.A. Calderwood (1 ♂, 2 ♀♀, CNC). **Newfoundland & Labrador:** Fogo Island, vii.1929, C.W. Johnson (1 ♂, CNC); Goose Bay, 24.viii.1947, W.E. Beckel (1 ♂, CNC); same locality, 7.vii.1952 (2 ♀♀, CNC). **Ontario:** Iroquois Falls, 21–30.vi.1987, J.R. Vockeroth (2 ♀♀, CNC); Thunder Bay Distr., Neys Prov.

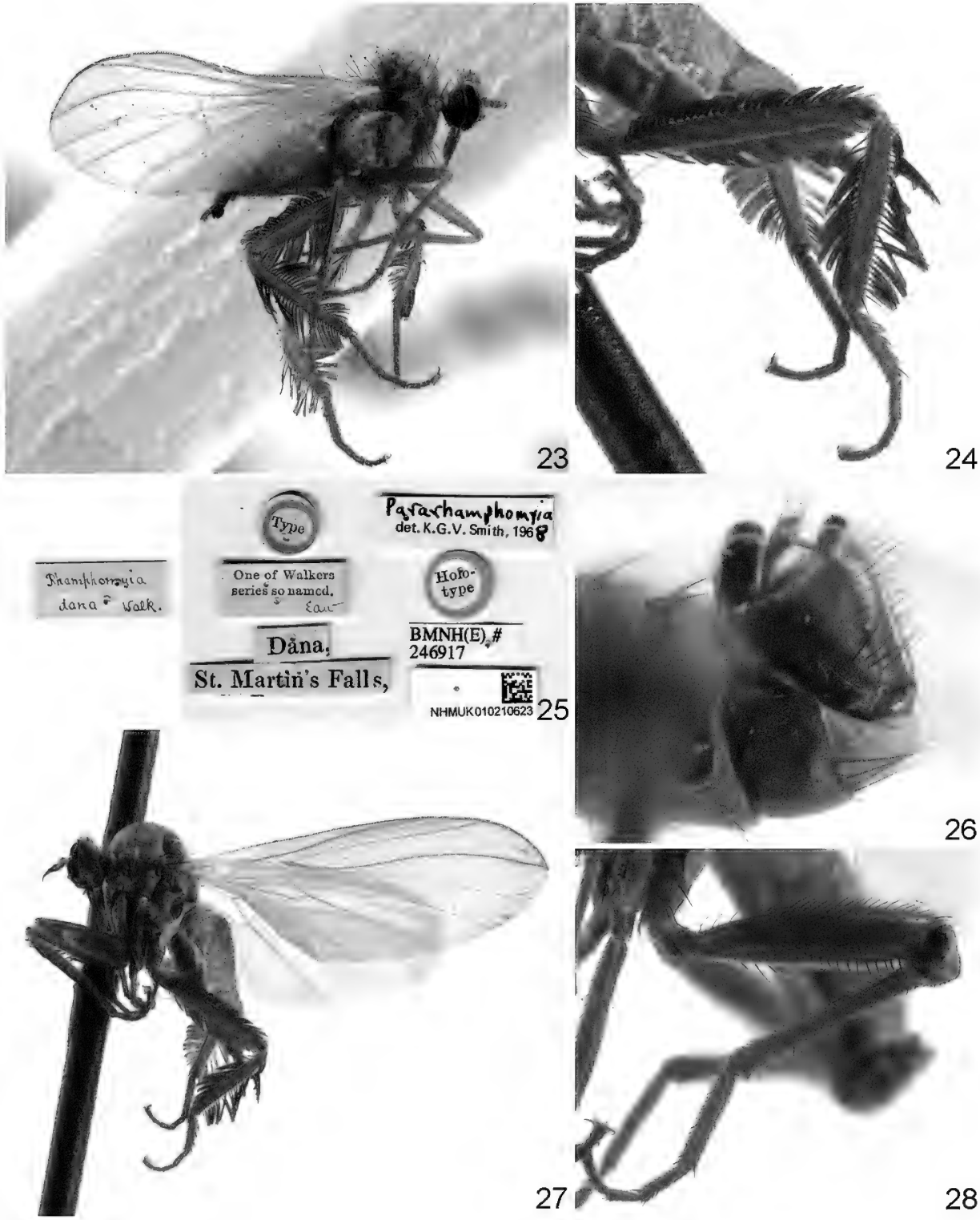
Figs 21–22. *Rhamphomyia poplitea* Wahlberg. **21.** Holotype, male, lateral view; **22.** Holotype label, upper three labels attached to specimen; lower label pinned to unit tray (photographs: Y. Brodin).

Pk, Dune Trail, 48°46′52″N, 86°36′53″W, MT, yellow pans, 7–19.vii.2002, M. Buck (2 ♀♀, UGIC); Thunder Bay Distr., Prairie R. at Hwy 17, 38 km E Terrace Bay, 48°48′N, 86°47′W, boggy spruce MT, 15–19.vii.2002, M. Buck (2 ♂♂, 4 ♀♀, UGIC). **Quebec:** Fort Chimo, 22.vii.1948, R.H. MacLeod (1 ♀, CNC); same locality, 7–9.vii.1954, J.F. McAlpine, E.E. Sterns (2 ♂♂, CNC); Indian House Lake, 9.vii.–15.viii.1954, W.R. Richards (31 ♂♂, 8 ♀♀, CNC) (Figs 24, 27, 28); James Bay Rte, km 204.5, 50°58′59″N, 77°38′2″W, black spruce/Sphagnum, MT, 7–16.vii.2001, M. & B. Buck (1 ♀, UGIC) (Fig. 26); James Bay Rte, km 578.4, 53°32′40″N, 77°40′40″W, dry lichen conifer forest, yellow pans, 9–15.vii.2001, M. & B. Buck (1 ♀, UGIC); Knob Lake, 54°47′N, 66°47′W, 16.vii.1948, E.G. Munroe (1 ♀, CNC); La Ferme, 1.vii.1943, A. Robert (1 ♂, CNC); Laniel, 19.vi.1939, F.P. Ide (1 ♀, CNC); same locality, 21.vi.1941, A.R. Brooks (1 ♂, CNC); Parke Reserve, Kamouraska, 11–17.vii.1957, G.E. Shewell (3 ♀♀, CNC). **Yukon:** Dempster Hwy, mi 87, 8–12.vii.1973, G.&D.M. Wood (1 ♀, CNC); Dempster Hwy, Eagle R. crossing; MT, 9–10.vii.1985, S.A. Marshall (1 ♂, UGIC). **FINLAND.** Enontekis, Palmén (1 ♂, 1 ♀, MZH), Enontekis, R. Frey (1 ♀, MZH); Muonio, R. Frey (1 ♂, MZH); Tiensu (1 ♂, MZH). **UNITED STATES OF AMERICA. Alaska:** King Salmon, Naknek River, 3–14.viii.1952, J.B. Hartley (1 ♂, 1 ♀, CNC).

Diagnosis. Females of this species are distinguished by long, broad and apically truncate dorsal and ventral pennate setae on the mid and hind femora and mid and hind tibia, longer than width of corresponding leg segment, and slender dorsal pennate setae on hind tarsomere 1; abdomen yellowish brown to pale brown, contrasting with grey thorax. Males are distinguished by the highly modified hind legs (characteristic of *basalis* group) and form of the male terminalia.

Redescription. Wing length 4.5–4.9 mm. **Male.** Head dark in ground-colour, with greyish pruinescence on face, frons, postgena and occiput; oral margin shiny reddish. Holoptic, eyes with ommatidia larger on upper half of eye, smaller on lower half. Frons divergent towards antennal sockets, bare. Margins of face slightly divergent. Ocellar triangle with pair of ocellar setae, shorter than postocular setae. Upper third of occiput bearing row of stout postocular setae, longer than ocellar setae; lower postocular setae slender and shorter. Occipital setae black and stout, extending ventrally; postgenal setae similar to occipital setae. Antenna dark; scape slightly longer than pedicel; postpedicel nearly 3× longer than basal width; stylus length about equal to length of scape. Palpus dark, slender, bearing single long, subapical seta. Clypeus bare, with greyish pruinescence; labrum dark and glossy, slightly longer than eye height; labellum dark and bearing many dark setae, shorter than palpal seta.

Thorax dark with dense grey pruinescence; brownish vittae beneath acrostichal and dorsocentral rows extending to prescutellar depression; posterior corner of postpronotal lobe and postalar ridge brownish. Prosternum bare; proepisternum at fusion point with prosternum with 1 stiff seta and sometimes several thinner setae; upper



Figs 23–28. *Rhamphomyia poplitea* Wahlberg. **23.** Holotype of *R. dana* Walker, female, lateral view; **24.** Recent specimen, female hind leg, anterior view; **25.** Holotype of *R. dana* Walker, labels, left label underside of corresponding label in centre row; **26.** Recent specimen, male terminalia, lateral view; **27.** Recent specimen, female, lateral view; **28.** Male hind leg, anterior view. See Additional material examined section for locality details of recent specimens.

part of proepisternum in front of anterior spiracle bare. Antepronotum with row of setae. Postpronotal lobe with 1 outstanding seta and several shorter, finer setae; acrostichals biserial, slightly shorter than dorsocentral setae; dorsocentrals uniserial, increasing in length posteriorly, prescutellar seta slightly shorter than scutellar setae, dorsocentral row curved towards postpronotal lobe anteriorly; 1 presutural supra-alar seta (posthumeral) and 1 posterior supra-alar seta (opposite anterior notopleural) longer and stouter; 1 anterior and 3–4 posterior notopleural setae, with several setulae near anterior notopleural seta; 2 prealar setae; 1 postsutural supra-alar setae; 1 postalar seta; 1 long apical pair and short lateral pair of marginal scutellar setae. Laterotergite with cluster of long, dark setae. Anterior and posterior spiracles yellowish brown.

Legs short, brown with pale "knees". Fore coxa with row of 5–6 stout anterolateral setae; lateral regions of mid and hind coxae with similar setae. Fore femur with row of fine anteroventral setae. Fore tibia with pale ventral pubescence. Mid femur with anteroventral row of short, even-length stout setae; posteroventral row of stout setae longer, greater than half width of femur. Mid tibia with anteroventral and posteroventral rows of very short, stout setae, shorter than ventral setae of femur. Hind femur greatly swollen, of uniform width on apical half (Figs 21, 28); anteroventral row of setae weak on basal half, stronger preapically; posteroventral row slender and long basally, decreasing evenly to setulae at apex. Hind tibia geniculate at base; straight, without crest of flattened setae and not flattened; setae of anteroventral row stout; anterodorsal setae numerous, some at least twice width of tibia; 1 long seta in posteroapical comb. Tarsomere 1 of all legs slender, with dense ventral setae.

Wing lightly infuscate (Fig. 21); pterostigma elongate, normally pale; short basal costal seta present. Cell dm subequal in length to cell bm; CuA+CuP unpigmented, reaching wing margin as crease; alular incision obtuse; margin of calypter with brown setae. Halter pale yellowish brown.

Abdomen brown, paler than thorax; posterior margins of tergites and sternites paler; clothed in dark setae, longer along posterior margin; setae finer and somewhat paler on ventrolateral margin. Tergite 7 narrower than sternite 7, with posterolateral and posterior margin more thickly sclerotized. Tergite 8 reduced to half-length of sternite 8, narrowed laterally; posterior margin of sternite 8 with long setae, longer than length of sclerite 8. Terminalia (Fig. 26) lighter brown, with apex of epandrium darkened. Hypandrium slender, wrapping around base of phallus. Epandrium subtriangular, produced posterior into slender rounded projection closed in very short, stout setae; posterior half clothed in long setae, some longer than half-length of epandrium. Subepandrial lobe digitiform; slightly arched with rounded apex; with 6–8 long setae on apical half. Cercus subrectangular with truncate apex, shorter than subepandrial lobe. Phallus broad and even throughout basal half; apical half strongly tapered and arched. Ejaculatory apodeme subtriangular, very large, as broad as length of hypandrium; horizontal lamella on posterior margin.

Female. Similar to male except: wing darkly infuscate (Fig. 27), broader than in male. Legs with long, broad and apically truncate dorsal and ventral pennate setae on the mid and hind femora and mid and hind tibiae, longer than width of corresponding leg segment, and slender dorsal pennate setae on hind tarsomere 1 (Figs 23–24, 27). Abdomen yellowish brown to pale brown, contrasting with grey thorax.

Geographic distribution. This species ranges across Canada and North America, from New Hampshire to Alaska (see Additional material examined). In the Palaearctic Region, *R. poplitea* occurs in Sweden, Finland and across Russia (Shamshev 2016).

Remarks. This species (as *valga* Coquillett) was included in the *R. basalis* group by Chillcott (1959). This species group is defined by the enlarged femur-tibia joint of the male hind leg (Fig. 28) (Chillcott 1959) and is assigned to the subgenus *Pararhamphomyia* Frey, 1922. Chillcott (1959) listed three European species that appear to be assigned to this species group on the basis of male genitalia, but apparently overlooked *R. poplitea*.

Rhamphomyia tristis Walker, 1857

Rhamphomyia tristis Walker, 1857: 148. Type locality: "United States".

Type material. Not available (see Smith 1971).

Remarks. According to Smith (1971), the type specimen has not been identified in BMNH and the Oxford University Museum of Natural History.

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REFERENCES

Barták M (2002) Nearctic species of *Rhamphomyia* subgenus *Megacyttarus* (Diptera: Empididae). Acta Universitatis Carolinae, Biologica 46: 3–215

Barták M, Kubík S (2009) Two new east Palaearctic *Rhamphomyia* (*Pararhamphomyia*) (Diptera: Empididae). Entomological News 120: 76–86

Chillcott JG (1959) Studies on the genus *Rhamphomyia* Meigen: a revision of the Nearctic species of the *basalis* group of the subgenus *Pararhamphomyia* Frey (Diptera: Empididae). The Canadian Entomologist 91: 257–275

Coquillett, D.W. (1895) Revision of the North American Empidae – A family of two-winged insects. Proceedings of the United States National Museum 18 (1896), 387–440

Cumming JM, Sinclair BJ, Brooks SE, O'Hara JE, Skevington JH (2011) The history of dipterology at the Canadian National Collection of Insects, with special reference to the Manual of Nearctic Diptera. In: Festschrift commemorating the coordinators of the Manual of Nearctic Diptera and their contributions to building the Canadian National Collection of Insects. Part 1. The Canadian Entomologist 143: 539–577

Cumming JM, Wood DM (2017) [Chapter] 3. Adult morphology and terminology. Pp. 89–133 in: Kirk-Spriggs AH & Sinclair BJ (eds) Manual of Afrotropical Diptera. Volume 1. Introductory chapters and keys to Diptera families. Suricata 4, South African National Biodiversity Institute, Pretoria

Danks HV (1981) Arctic arthropods. A review of systematics and ecology with particular reference to the North American fauna. Entomological Society of Canada, Ottawa

Evenhuis NL (2018) The life and work of Francis Walker (1809–1874). Fly Times, Supplement 2: 1–101

Loew H (1861) Diptera Americae septentrionalis indigena. Centuria prima. Berliner Entomologische Zeitschrift 5: 307–359

Melander AL (1965) Family Empididae (Empidae, Hybotidae). Pp. 446–481 in: Stone A, Sabrosky CW, Wirth WW, Foote RH & Coulson JR (eds) A Catalog of the Diptera of America north of Mexico. United States Department of Agriculture, Agriculture Handbook No. 276

Poole RW (1996) Diptera. Pp. 15–604 in: Poole RW & Gentili P (eds), Nomina Insecta Nearctica. A Check List of the Insects of North America. Volume 3: Diptera, Lepidoptera, Siphonaptera. Entomological Information Services, Rockville, MD

Saigusa T (1963) Some new species of the genus *Rhamphomyia* from Japan, with descriptions of two new subgenera (Diptera, Empididae). Sieboldia 3 (1): 131–166

Saigusa T (2012) A new Asio-Nearctic subgenus of *Rhamphomyia* (Diptera: Empididae: Empidinae). The Canadian Entomologist 144: 291–322

Shamshev IV (2016) An annotated checklist of empidoid flies (Diptera: Empidoidea, except Dolichopodidae) of Russia. Proceedings of the Russian Entomological Society 87: 3–183

Sinclair BJ, Vajda EA, Saigusa T, Shamshev IV & Wheeler TA (in prep.) *Rhamphomyia* Meigen of the Canadian Arctic Archipelago, Greenland and Iceland (Diptera: Empididae)

Smith KGV (1971) A revision of Francis Walker's types of North American Empididae (Diptera). Bulletin of the British Museum (Natural History), Entomology 26 (8): 347–370, pls 1–3

Wahlberg E (1844) Nya Diptera från Norrbotten och Luleå Lappmark. Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlinger 1: 106–110

Walker F (1849). List of specimens of dipterous insects in the collection of the British Museum. Part III, London.

Walker F (1857) Characters of undescribed Diptera in the collection of W.W. Saunders, Esq., F.R.S., &c. Transactions of the Entomological Society of London 4: 119–158

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Research article

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Specimen labelling errors: birds collected on the Falkland Islands prior to 1861, now in Naturalis Biodiversity Center, Leiden, Netherlands

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Abstract. Historical museum specimens are often documented by labels or by handwritten notations on the pedestal underside. However, mistakes and misinterpretations of specimen data often occur due to a complete lack of such data or in the transcription of data from original sources (either in the form of original labels or personal communications). This paper discusses the errors and omissions in data found on 89 specimens collected in the Falkland Islands before 1861, present or formerly present in Naturalis Biodiversity Center (Leiden, Netherlands), resulting from label substitution and transcription errors. Errors and omissions in data include location, collector, collecting locality and date. The corruption of original data shows that the gravest error made at that time was the disposal of the original labels.

Key words. Bird collection, Ornithology, Falkland Islands, Charles Abbott.

INTRODUCTION

Ornithology in the early nineteenth century flourished worldwide, but up to 1861 relatively few expeditions with natural history objectives collected birds in the Falkland Islands (Jansen & van der Mije 2015). The Falklands rose to fame when Charles Darwin published accounts of the birds and mammals encountered (Darwin 1839, 1859) when HMS *Beagle* visited in 1833 and 1834. We find published accounts of other expeditions up to 1861 (Lesson & Garnot 1826–30, Darwin 1839, Freycinet et al. 1837, MacGillivray 1852), when Captain Charles Compton Abbott left the Falklands (Abbott 1860, 1861).

To get a better understanding of the birds collected in the Falkland Islands, all specimens in the Naturalis Biodiversity Center, Leiden, Netherlands (hereafter Naturalis) or noted in the literature that were collected in the Falkland Islands or arrived at Naturalis prior to 1 January 1862, were analysed. In total, 89 specimens, represented by mounts or skins, were examined. A number of these specimens have been previously cited by earlier authors (Schlegel 1862a, b, c, d, 1863a, b, c, d, 1864, 1865, 1866, 1867, van Grouw & Steinheimer 2008).

The labelling of bird specimens in Naturalis has been the subject of research by a few previous authors, with a special focus on the removal of original labels (Mees 1953, Mees & Fisher 1986, Rasmussen & Prŷs-Jones 2003). However, their focus was on a single labelled bird of Edgar Leopold Layard's (Mees & Fisher 1986) and Karl B.H. von Rosenberg's birds from Indonesia (Mees 1953, Rasmussen & Prŷs-Jones 2003). No extensive research has yet been carried out on a large series of birds with regard to their label substitution and transcription errors. The research conducted for this paper was carried out in order to establish how much such 'vandalism' of Falkland Islands birds has occurred in Naturalis.

Jansen & van der Mije (2015) noted that various sources in addition to the known expeditions collected birds and mammals in the Falkland Islands. The original sources are therefore often hard, or in most cases even impossible, to trace.

Major expeditions and collectors that collected birds in the Falklands include:

- *L'Uranie*, 15 February–27 April 1820. '65+' birds (appendix 1) that arrived at the Museum national d'Histoire naturelle, Paris (hereafter MNHN) have annotations that they were collected in the Falklands (MNHN archives).
- *La Coquille*, 18 November–18 December 1825. 42 birds (appendix 2) that arrived at the MNHN have annotations that they were collected in the Falklands (MNHN archives).
- HMS *Beagle*, 1 March–5 April 1833 and 11 March–7 April 1834. 33 birds were collected by Charles Darwin and Syms Covington on the Falklands (Steinheimer 2004). And 24 specimens from the Falklands were collected by Captain Robert Fitzroy on the HMS *Beagle* expedition and donated in by Sir William Burnett in 1838 (Natural History Museum Tring, UK (herafter NHMUK)).

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- HMS *Erebus* and *Terror*, 6 April–8 September 1842. 142 birds and eggs donated to the NHMUK by Robert McCormick in 1890 and 1891 (Sharpe 1906).
- HMS *Rattlesnake*, 5–25 July 1850. Specimens were presented to the NHMUK by Owen Stanley in 1850, 1854 and 1855, totalling 219 specimens, and 16 birds by William McGillivray in 1851 (Sharpe 1906).
- Charles Compton Abbott (1821–1887), August 1857–December 1860. The Hobart (Tasmania) born officer entered the army at 22 July 1844, and served in the 13th, 20th, 75th, and 47th Regiments. He commanded the detachment at the Falkland Islands for four or five years (became captain in March 1858). He returned to Australia, and after serving in the North Glouchester Militia in 1862–69, he was transferred to the Queen's Country Royal Rifles, he retired from service in 1876. Abbott was in command of the British forces stationed at Stanley on East Falkland. Abbott made various excursions into the interior, both in the north and in the south of East Falkland and lost no opportunity to collect eggs and skins (Darwin 1871, Jansen & van der Mije 2015). Specimens collected by Abbott ended up in a number of collections. No less then 46 specimens (possibly as many as 76) in Naturalis were received directly from Abbott, as indicated by Abbott being mentioned on the label and/or pedestal.

27 birds in Naturalis acquired from Gustav Adolph Frank Sr., for which there are no specific collectors mentioned on their labels, most likely originate with Abbott also, although this remains speculative. While Abbott may have sold his birds to Frank and John Gould, he probably did so only to Gould, who in turn sold them to Frank, and Frank in turn to others such as the merchant Charles Jamrach and the Zoological Society of London (ZSL). Of four Falkland birds examined in the NHMUK from the ZLS, only one mentions Abbott as its source on its label (though this is not the original label). Specimens from Abbott arrived in the NHMUK via John Henry Gurney (in particular raptors), an 1859 shipment from Gould (comprising 132 birds and eggs) and from the ZLS (Sharpe 1906). The Abbott labels are easy recognizable as they are printed labels, with Abbott's own handwriting on them (Figs. 2, 3).

This paper is not intended to re-label the specimens from archival research and no such research was executed, although known information is given.

MATERIAL AND METHODS

The 89 birds discussed in this article were found by researching the relevant literature (Schlegel 1862a, b, c, d, 1863a, b, c, d, 1864, 1865, 1866, 1867) and by visits to Naturalis on 18 December 2012, 11 February 2013 and 3 December 2015. Additional visits were made to Museum national d'Histoire naturelle, Paris (hereafter MNHN) on 2–12 April 2013 and to the Natural History Museum, Tring (hereafter NHMUK) on 12–13 November 2013, 18 June 2015 and 23 March 2016. These visits were made to establish if original labels on Falkland Islands specimens were present. 25 Falkland specimens in MNHN were examined and 103 Falkland specimens in NHMUK. Literature was also consulted to find additional information on dates when and where specific specimens were collected, and by whom.

Aware that specimens are assigned to "Falklands" or to "East Falkland" on the basis of label data, could well be the location from where it is mailed/shipped to Europe. However, besides some penguin species no odd records were found. Research revealed that the main collector Abbott is known to travelled extensively on East Falkland and collected all kinds of natural history material (Lanjouw & Staffleu 1954), and the known expeditions did not ship specimens from the Falklands to Europe.

The two research questions are:

- What were the transcription errors made on the available sources?
- Did the specimens at Naturalis once had these original labels?

RESULTS

The specimens

No synonyms are given, only the actual English and Latin name. The framework as set by Steinheimer 2010 is followed with some slight modifications.

Abbreviations

Loc = locality,
Col = collected by,
Acq = Acquisition history,
Tax = taxidermy,
Pub = Publications mention the specimen or collecting trip.

Taxonomy and nomenclature follow del Hoyo & Collar (2014, 2016).

Anatidae

Upland Goose *Chloephaga picta leucoptera* (J.F. Gmelin, 1789) [RMNH.AVES.230417]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: November–December 1822. Col: voyage *La Coquille*, R.P. Lesson / P. Garnot. Age/sex: adult ♂. Acq: June 1835, in exchange with the Paris Museum. Status: extant. Accessed: 18

December 2012. Tax: mounted. Pub: Lesson & Garnot 1826–1830; Schlegel 1866.

Pedestal label: [two hands] Cat nº1 / *leucoptera* / *Chloëphaga* ~~*magellanica*~~ / (Gmelin) / ♂ / verzameld tijdens / de reis van "La Coquille" / Falkland eilanden [two hands].

Pedestal underside: [one hand] *Anser magellanicus* ♂ / *Anser leucopterus* / *Anas leucoptera Lath* / Oie a ailes blanches Buff vol 9 / Brown Ill talo 40 / Cat Nº1 / voy La *Coquille* / Malouines.

Schlegel 1866 (Tome VI, 31: 99–100): *Anser magellanicus*, Cat 1, ♂ adulte, Malouines, voyage de *la Coquille*.

Remarks: The collection site on the label ("Falkland eilanden") differs from that on the underside and Schlegel 1866 ("Malouines"). Several Latin names are cited, those on the label and underside differ; the primary name on the latter however agrees with Schlegel 1866. The notation of "adulte" is present only in Schlegel 1866, and is lacking on the label and underside. Gmelin is noted as the name source on the label, Buffon as the source on the underside. Only Schlegel's handwriting appears under the base of the pedestal.
Mentioned in the June 1835 exchange list between Paris and Leiden as '*Oie des torres Magellanicus*'. The stand is 'new' (e.g. it has Temminck's handwriting) and does not contain any original information / handwriting by Dufresne (the mounted birds from *La Coquille* now present in MNHN have Dufresne's handwriting on the pedestal underside). A possible explanation is that it arrived in Leiden as an unmounted skin and was subsequently mounted there.

Upland Goose *Chloephaga picta leucoptera* (J.F. Gmelin, 1789) [RMNH.AVES.230418]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♂. Acq: –. Status: extant. Accessed: 18 December 2012. Tax: mounted. Publ: Schlegel 1866.

Pedestal label: [two hands]. Cat nº2 / *leucoptera* / *Chloëphaga* ~~*magellanica*~~ / (Gmelin) / ♂ / Falkland eilanden.

Pedestal underside: [one hand] *Anser magellanicus* ♂ / *Anser leucopterus* / *Anas leucoptera* Lath. / *Oie a ailes blanches* Buff v9 / Brown Ill talo 40 / Cat Nº2 / Malouines [one hand].

Schlegel 1866 (Tome VI, 31: 99–100): *Anser magellanicus*, Cat 2, ♂ adulte, Malouines.

Remarks: The collection site on the label ("Falkland eilanden") differs from that on the underside and Schlegel 1866 ("Malouines"). Several Latin names are cited; those on the label and underside differ; the primary name on the latter however agrees with Schlegel 1866. The notation of "adulte" is present only in Schlegel 1866, and is lacking on the label and underside. Gmelin is noted as the name source on the label, Buffon, Latham and Brown as sources on the underside. Only Schlegel's handwriting appears under the base of the pedestal.
In June 1835 two specimens where sent from the Paris Museum as part of an exchange; this could be one of those birds. Most likely collected by Lesson / Garnot in Nov–Dec 1822. One specimen of *Chloephaga picta* is missing from HMS *Beagle* (Steinheimer 2004).

Upland Goose *Chloephaga picta leucoptera* (J.F. Gmelin, 1789) [RMNH.AVES.230419]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♀. Acq: –. Status: extant. Accessed: 18 December 2012. Tax: mounted. Pub: Schlegel 1866.

Pedestal label: [two hands] Cat nº3 / *leucoptera* / *Chloëphaga* ~~*magellanica*~~ / (Gmelin) / ♀ / Falkland eilanden.

Pedestal underside: [one hand] *Anser magellanicus* ♀ / *Anas magellanica* Lath / *Oie der Terres magellaniques* Buff / pl Pub / 1006 / unreadable femelle / Cat Nº3 / Malouines.

Schlegel 1866 (Tome VI, 31: 99–100): *Anser magellanicus*, Cat 3, Femelle adulte, Malouines.

Remark: The collection site on the label ("Falkland eilanden") differs from that on the underside and Schlegel 1866 ("Malouines"). Several Latin names are cited; those on the label and underside differ; the primary name on the latter however agrees with Schlegel 1866. The notation of "adulte" is present only in Schlegel 1866, and is lacking on the label and underside. Gmelin is noted as the name source on the label, Buffon and Latham as sources on the underside. Only Schlegel's handwriting appears under the base of the pedestal.
In June 1835 two specimens where sent from the Paris Museum as part of an exchange; this could be one of those birds. Most likely collected by Lesson / Garnot in Nov–Dec 1822. One specimen of *Chloephaga picta* is missing from *HMS Beagle* (Steinheimer 2004).

Kelp Goose *Chloephaga hybrida malvinarum* J.C. Phillips, 1916 [RMNH.AVES.230431]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♂. Acq: –. Status: extant. Accessed: 18 December 2012. Tax: mounted. Pub: Schlegel 1866.

Pedestal label: [two hands] Cat nº1 / *Chloophaga hybrida* / (~~Molina~~) / ♂ *malvinarum* Phillips / Falkland eilanden.

Pedestal underside: [one hand] *Anser antarcticus* ♂ ad / Sparm. mus (ext. note la ♀ pl 5) / Cat Nº1 / Malouines.

Schlegel 1866 (Tome VI, 31: 98–99): *Anser antarcticus*, Cat 1, ♂ adulte, au plumage d'un blanc uniforme, Malouines: bec noir, mais entre les narines et le front rougeatre avec des taches noires.

Remarks: The collection site on the label ("Falkland eilanden") differs from that on the underside and Schlegel 1866 ("Malouines"). Several Latin names are cited; those on the label and underside differ; the name on the latter however agrees with Schlegel 1866. The notations of "ad" and "adulte" are present on the underside and in Schlegel 1866, but lacking on the label. Phillips is noted as the name source on the label, Sparmann's Museum as the source on the underside. Only Schlegel's handwriting appears under the base of the pedestal.

Kelp Goose *Chloephaga hybrida malvinarum* J.C. Phillips, 1916 [RMNH.AVES.230432]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: November–December 1822. Col: voyage *La Coquille*, R.P. Lesson / P. Garnot. Age/sex: adult ♀. Acq: June 1835, in exchange with Paris Museum. Status: extant. Accessed: 18 December 2012. Tax: mounted. Pub: Lesson & Garnot 1826–1830; Schlegel 1866.

Pedestal label: [two hands] Cat. nº2 / *Chloephaga hybrida* / (~~Molina~~) / ♀ *malvinarum* Phillips / Verzameld tijdens / de reis van / "La Coquille" / Falkland eilanden [two hands].

Pedestal underside: [one hand] *Anser antarcticus* ♀ Vieill / Sparm Mus Carl pl 37 / Less *Coquille* pl 50 / De antarctique femelle / Cat Nº2 / Coquille Malouines [one hand].

Schlegel 1866 (Tome VI, 31: 98–99): *Anser antarcticus*, Cat 2, Femelle adulte, Malouines, du voyage de *la Coquille*, absolument semblable a l'individu figure par Lesson.

Remark: The collection site on the label ("Falkland eilanden") differs from that on the underside and Schlegel 1866 ("Malouines"). Several Latin names are cited; those on the label and underside differ; the name on the latter however agrees with Schlegel 1866. The notation of "adulte" is present only in Schlegel 1866, and is lacking on the label and underside. Phillips is noted as the name source on the label, Vieillot, Sparmann's Museum, and Lesson as the sources on the underside. Only Schlegel's handwriting appears under the base of the pedestal.

Mentioned in the June 1835 exchange list between Paris and Leiden as '*Oie des torres Magellanicus*'.

Kelp Goose *Chloephaga hybrida malvinarum* J.C. Phillips, 1916 [RMNH.AVES.230433]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: young ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant. Accessed: 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] Cat nº3 / *Chloephaga hybrida* / ~~Molina~~ / ♂ juv. *malvinarum* Phillips / Abbott coll: / Frank 1860 / Falkland eilanden.

Pedestal underside: [one hand] *Anser antarcticus* / ♂ jong / Pooten geel, iris en bek zwart / Cat Nº3 / Reis van Capitain Abbott / Frank 1860 / Falkland.

Schlegel 1866 (Tome VI, 31: 98–99): *Anser antarcticus*, Cat 3, ♂ dans la livree de passage, Malouines, voyage du Capitaine Abbot, acquis en 1860: pieds jaunes, vec et iris noirs (Abbot).

Remarks: The collection site on the label ("Falkland eilanden") differs from that on the underside "Falkland") and Schlegel 1866 ("Malouines"). Several Latin names are cited; those on the label and underside differ; the name on the latter however agrees with Schlegel 1866. Phillips is noted as the name source on the label; no name source appears on the underside. Only Schlegel's handwriting appears under the base of the pedestal.

Army Captain Charles Compton Abbott was stationed at Stanley, East Falklands in 1859–1861 in the Falkland Islands Detachment. He collected many birds and attached printed labels to his specimens. These labels had his full name and that of his regiment printed on one side, on the other side, he noted in pen the year, collecting location and details of the bare parts. These original labels can be found in NHMUK. So, contra the underside and Schlegel 1866, Abbott did not collect while on a "voyage" or "Reis"; moreover, his name is misspelled in Schlegel 1866. This specimen was acquired via Gustav Adolph Frank, the Amsterdam-based merchant who, though he did not collect a single bird himself, exchanged and purchased birds on a large scale with the likes of the Paris Museum and John Gould, both known to possess specimens from the Falklands (in particular those collected by C.C. Abbott). However, Frank is not mentioned as the source of this specimen in Schlegel 1866.

Ashy-headed Goose *Chloephaga poliocephala* P.L. Sclater, 1857 [RMNH.AVES.230436]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♂. Acq: –. Status: extant. Accessed: 18 December 2012. Tax: mounted. Pub: Schlegel 1866.

Pedestal label: [one hand] Cat nº2 / *Chloëphaga poliocephala* / G.R. Gray / ♂ / Falkland eilanden.

Pedestal underside: [one hand] *Anser poliocephala* / *Bernicla inornatus* ♂ / Cat nº2 / *Bernicla inornatus* Gray / Gen of Birds (unreadable) / (unreadable line) / Malouines.

Schlegel 1866 (Tome VI, 31: 101): *Anser poliocephala*, Cat 2, Adulte, Malouines.

Remarks: The collection site on the label differs from that on the underside and Schlegel 1866. Three generic and two specific names are cited; those on the label and underside differ; the primary binomial on the latter however agrees with Schlegel 1866. The identification as ♂ is absent from Schlegel 1866 and as an adult from the label and underside. The only name source mentioned is Gray on the underside. Only Schlegel's handwriting appears under the base of the pedestal.

Ruddy-headed Goose *Chloephaga rubidiceps* P.L. Sclater, 1861 [RMNH.AVES.230443]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♂. Acq: via Gustav Adolph Frank Sr. Status: extant. Accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1866.

Pedestal label: [one hand] Cat nº1. / *Chloëphaga rubidiceps* / Sclater / ♂ / Falkland eilanden.

Pedestal underside: [one hand] *Bernicla* / *Anser rubidiceps*. / tres 1860 / ♂ / Catal Nº 1 / Malouines.

Schlegel 1866 (Tome VI, 31: 102): *Chloephaga rubiceps*, Cat 1, ♂ adulte, Malouines.

Remarks: The collection site on the labeldiffers from that on the underside and Schlegel 1866. Two generic names are cited; those on the label and underside differ; the binomial on the label however agrees with Schlegel 1866. The identification as adult is present only in Schlegel 1866. The only name source mentioned is Sclater on the label. Only Schlegel's handwriting appears under the base of the pedestal.

This specimen was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 above) and arrived on 30 April 1860, as indicated on the underside.

Ruddy-headed Goose *Chloephaga rubidiceps* P.L. Sclater, 1861 [RMNH.AVES.230445]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: –. Acq: –. Status: extant. Accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1866.

Label: [one hand] Cat nº3. / *Chloëphaga rubidiceps* / Sclater / Falkland eilanden.

Pedestal underside: [one hand] *Chloëphaga rubidiceps* / Falkland.

Schlegel 1866 (Tome VI, 31: 102): not mentioned.

Remark: Notably missed by Schlegel 1866, yet only Schlegel's handwriting appears under the base of the pedestal. The only name source mentioned is Sclater on the label. The collection site on the label ("Falkland eilanden") differs from that on the underside ("Falkland").

Falkland Steamer Duck *Tachyeres brachypterus* Latham, 1790 [RMNH.AVES.230636]. Loc: Falklands

(*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr.; though not specified, most likely arrived on 30 April 1860. Status: extant. Accessed: 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: absent.

Pedestal underside: [one hand] (unreadable) / *Fuligula cinerea* / Cat N°1 / N°.3 / Loggerhead Duck / ♂ / *Tachyeres brachyptera* (Lath) / Reis van Capitain Abbott / (Frank) 1860 / Falkland.

Schlegel 1866 (Tome VI, 31: 13): *Fuligula cinerea*, Cat 1, ♂ adultes, Malouines, voyage de Mr. Abbot, acquis en 1860.

Remarks: The collection site on the underside differs from that in Schlegel 1866. Two generic and two specific names are cited, with the primary binomial on the underside agreeing with Schlegel 1866. Both the underside and Schlegel 1866 identify the specimen as male, but only the latter identifies it as an adult. The only name source mentioned is Latham on the underside. Only Schlegel's handwriting appears under the base of the pedestal.

This specimen was acquired in 1860 from the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 above).

Falkland Steamer Duck *Tachyeres brachypterus* Latham, 1790 [RMNH.AVES.230637]. Loc: Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr.; though not specified, most likely arrived on 30 April 1860. Status: extant. Accessed: 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: absent.

Pedestal underside: [one hand] (unreadable)/ *Fuligula cinerea* / Cat N°2 / Loggerhead Duck / ♀ / *Tachyeres brachyptera* (Lath) / Van Cap Abbott / Falkland Island Detachment / Frank / Falkland.

Schlegel 1866 (Tome VI, 31: 13): *Fuligula cinerea*, Cat 2, ♀ adultes, Malouines, voyage de Mr. Abbot, acquis en 1860.

Remarks: The collection site on the underside differs from that in Schlegel 1866. Two generic and two specific names are cited, with the primary binomial on the underside agreeing with Schlegel 1866. Both the underside and Schlegel 1866 identify the specimen as female, but only the latter identifies it as an adult. The only name source mentioned is Latham on the underside. Only Schlegel's handwriting appears under the base of the pedestal. The text on the underside clearly indicates the former existence of an original label on the specimen.

The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Falkland Steamer Duck *Tachyeres brachypterus* Latham, 1790 [–]. Loc: Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: –. Col: –. Age/sex: –. Acq: –. Status: non-extant; not found on 18 December 2012 or 11 February 2013. Tax: mounted. Pub: Schlegel 1866.

Schlegel 1866 (Tome VI, 31: 13): *Fuligula cinerea*, Cat 3, Individue en mue, Malouines.

Remarks: Present location of specimen and the original collector unknown.

Crested Duck *Lophonetta specularioides specularioides* (P.P. King, 1828) [RMNH.AVES.231375]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant. Accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] Cat n°2 / *specularioides* King / *Anas* ~~*cristata* Gmelin~~ / ♂ / Abbott coll / Frank 1860 / Falkland.

Pedestal underside: [one hand] *Anas cristata* Gmel / Cat N°3 / ♂ / eye red, feat and beak lead color / Capt Abbot / Frank 1860 / Falklands eilanden / (unreadable).

Schlegel 1866 (Tome VI, 31: 39): *Anas cristata*, Cat 3, ♂ adultes, iles Malouines, voyage du Capitaine Abbot, acquis en 1860, Iris rouge, pieds et bec coleur de plomb.

Remarks: The collection site on the label, underside and in Schlegel 1866 differ. Two specific names are cited, with the primary binomial on the underside agreeing with Schlegel 1866. The label, underside, and Schlegel 1866 all identify the specimen as male, but only the latter identifies it as an adult. Two name sources are mentioned, King on the label and Gmelin on the underside. The catalogue number on the label doesn't correspond with the catalogue number on the underside and in Schlegel 1866. Only Schlegel's handwriting appears under the base of the pedestal.

The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Crested Duck *Lophonetta specularioides specularioides* (P.P. King, 1828) [RMNH.AVES.231376]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant. Accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] Cat n°3 / *specularioides* King / *Anas* ~~*cristata* Gmelin~~ / ♀ / Abbott coll / Frank 1860 / Falkland eilanden.

Pedestal underside: [one hand] *Anas cristata* Gmelin / Cat N° 4 / ♀ / Reis van / Capt Abbot / Frank 1860 / ~~1860~~ / Oost Falkland.

Schlegel 1866 (Tome VI, 31: 39): *Anas cristata*, Cat 4, ♀ adultes, iles Malouines, voyage du Capitaine Abbot, acquis en 1860, Iris rouge, pieds et bec coleur de plomb.

Remarks: The collection site on the label, underside and in Schlegel 1866 differ. Two specific names are cited, with the primary binomial on the underside agreeing with Schlegel 1866. The label, underside, and Schlegel 1866 all identify the specimen as female, but only the latter identifies it as an adult. Two name sources are mentioned, King on the label

and Gmelin on the underside. The catalogue number on the label doesn't correspond with the catalogue number on the underside and in Schlegel 1866. Only Schlegel's handwriting appears under the base of the pedestal.
The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Silver Teal *Spatula versicolor fretensis* (P.P. King, 1831) [RMNH.AVES.231525]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant. Accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Anas* Cat nº6 / ~~*Querquedula*~~ *versicolor* / ♂ / Abbott coll / Frank 1861 O. Falkland eilanden.

Pedestal underside: [one hand] *Anas versicolor,* Vieillot / Cat nº6 (major) / ♂ / van Cap. Abott / Frank 1860 Oost Falkland.

Schlegel 1866 (Tome VI, 31: 57): *Anas versicolor*, Cat 6, ♂ adulte, ile orientales des Malouines, voyage du Capitaine Abbot, acquis en 1860.

Remarks: The collection site on the label, underside and in Schlegel 1866 differ. Two generic names (one crossed out) are cited, with the primary binomial on the underside agreeing with Schlegel 1866. The label, underside, and Schlegel 1866 all identify the specimen as female, but only the latter identifies it as an adult. Only one name source is mentioned, Vieillot on the label. Only Schlegel's handwriting appears under the base of the pedestal.
The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Silver Teal *Spatula versicolor fretensis* (P.P. King, 1831) [RMNH.AVES.231526]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant. Accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Anas* Cat nº7 / ~~*Querquedula*~~ *versicolor* / ~~(~~Vieillot~~)~~ / ♀ / Abbott coll: / Frank 1860 O. Falkland eilanden.

Pedestal underside: [one hand] *Anas versicolor* / (major) / Catal. Nº7. / ♀ / Beak base yellow, remainder (unreadable) (Abbot) / van Cap. Abott / (Frank 1860) Oost Falkland.

Schlegel 1866 (Tome VI, 31: 57): *Anas versicolor*, Cat 7, ♀ adulte, ile orientales des Malouines, voyage du Capitaine Abbot, acquis en 1860.

Remarks: The name giving of the location of collecting is different in underside, label and Schlegel 1866. The sexing of the specimen is noted in all both sources, the ageing however is only present in Schlegel 1866. Only Schlegel's handwriting under the base of the pedestal.
The collection site on the label, underside and in Schlegel 1866 differ. Two generic names are cited (one crossed out), with the primary binomial on the underside agreeing with Schlegel 1866. The label, underside, and Schlegel 1866 all identify the specimen as female, but only the latter identifies it as an adult. No name sources are mentioned. Only Schlegel's handwriting appears under the base of the pedestal.
The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Cinnamon Teal *Spatula cyanoptera cyanoptera* (Vieillot, 1816) [RMNH.AVES.231631]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant. Accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Anas* Cat Nr6 / ~~*Querquedula*~~ *cyanoptera* / ~~(~~Vieillot~~)~~ / ♂. / Abbott coll. / Frank, 1861 / Falkland eilanden.

Pedestal underside: [one hand] *Anas cyanoptera* / Cat Nº6 / ♂ / Iris geelrood, pooten geel / snavel zwart / (Abbot) / van Capt Abbot / Frank 1861. Oost Falkland.

Schlegel 1866 (Tome VI, 31: 51–52): *Anas cyanoptera*, Cat 6, ♂ adulte, iles Falkland, voyage du Capitaine Abbot, acquis en 1861.

Remarks: The collection site on the label, underside and in Schlegel 1866 differ. Two generic names are cited (one crossed out), with the primary binomial on the underside agreeing with Schlegel 1866. The label, underside, and Schlegel 1866 all identify the specimen as male, but only the latter identifies it as an adult. Only one name source is mentioned, Vieillot on the label. Only Schlegel's handwriting appears under the base of the pedestal.
The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Cinnamon Teal *Spatula cyanoptera cyanoptera* (Vieillot, 1816) [RMNH.AVES.231625]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: either 1858 or 1859. Coll. C.C. Abbott. Age/sex: ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant. Accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Anas* Cat Nº11. / ~~*Querquedula*~~ *discors*. (L) / ♀ / Abbott coll 1860 / Falkland eilanden.

Pedestal underside: [one hand] *Anas discors* / Cat Nº9 / ♀ / Iris zwart, pooten en bek bruinachtig / Cap Abbot / Oost-Falkland.

Schlegel 1866 (Tome VI, 31: 50–51): *Anas discors*. Cat 9, Femelle, iles Falkland, voyage du Capitaine Abbot, acquis en 1860.

Remarks: The collection site on the label, underside and in Schlegel 1866 differ. Two generic names are cited (one crossed out), with the primary name on the underside agreeing with Schlegel 1866. The label, underside, and Schlegel 1866 all identify the specimen as female, but none identify the age. No name source is mentioned. Only Schlegel's handwriting appears under the base of the pedestal. The identification is incorrect.

The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Chiloe Wigeon *Mareca sibilatrix* (Poeppig, 1829) [RMNH.AVES.230928]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] Cat nº3 / *Mareca sibilatrix* / (Pöppig) / ♂ / Abbott coll. / Frank, 1860 / Falkland eilanden.

Pedestal underside: [one hand] *Anas chiloensis* / Cat Nº5 / ♂ / Capt Abbot / (Frank 1860) / Oost Falkland.

Schlegel 1866 (Tome VI, 31: 46): *Anas chiloensis*, Cat (No number), ♂ adulte, iles Falkland, voyage du Capitaine Abbot, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1866 differ. The label, underside, and Schlegel 1866 all identify the specimen as male, but only the latter identifies it as an adult. Only one name source is mentioned, Poeppig on the label. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Yellow-billed Pintail *Anas georgica spinicauda* Vieillot, 1816 [RMNH.AVES.231462]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Anas* Cat nº3 / ~~*Dafila* spinicauda~~ / (Vieillot) / ♂ / Abbott coll. / Frank, 1860 / Falkland eilanden.

Pedestal underside: [one hand] *Anas spinicauda* / Cat Nº3 / ♂ / (unreadable) zwart, snavel geel, bovenkaak aan de / kant van top met een zwarten band (zeldzaam) / van Capit Abbott / Frank 1860 / Oost Falkland.

Schlegel 1866 (Tome VI, 31: 38–39): *Anas spinicauda*, Cat 3, ♂ adulte, iles Malouines, voyage du Captaine Abbot, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1866 differ. The label, underside, and Schlegel 1866 all identify the specimen as male, but only the latter identifies it as an adult. Only one name source is mentioned, Vieillot on the label. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Yellow-billed Pintail *Anas georgica spinicauda* Vieillot, 1816 [RMNH.AVES.231463]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Anas* Cat nº4 / ~~*Dafila* spinicauda~~ / (Vieillot) / ♀ / Abbott coll: / Frank, 1860 / Falkland eilanden.

Pedestal underside: [one hand] *Anas spinicauda*, Vieillot / Cat Nº4 / ♀ / pooten en bek (unreadable), het mannetje (unreadable) / Cap. Abbot / Frank 1860 / Oost Falkland.

Schlegel 1866 (Tome VI, 31: 38–39): *Anas spinicauda*, Cat 4, ♀ adulte, iles Malouines, voyage du Captaine Abbot, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1866 differ. The label, underside, and Schlegel 1866 all identify the specimen as female, but only the latter identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Yellow-billed Teal *Anas flavirostris flavirostris* Vieillot 1816 [RMNH.AVES.231104]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Anas* Cat nº1 / ~~*Nettion*~~ / *Anas flavirostris* / (Vieillot) / ♂ / Abbott coll: / Frank, 1860 / Falkland eilanden.

Pedestal underside: [one hand] *Anas flavirostris* Vieillot / Cat 3 / *Querquedula anaustirostra* Philippi & Landbeck / (1863) (unreadable) / ♂ / oogen zwart, snavel geel / zwart in / een lijn op de bovenkaak zwart / pooten roodkleurig groenachtig / (Abbot) / Capt Abbot / (frank 1860 / Falkland.

Schlegel 1866 (Tome VI, 31: 59): *Anas flavirostris*, Cat 1, ♂ adultes, iles Falkland, voyage de Mr. Abbot, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1866 differ. The label, underside, and Schlegel 1866 all identify the specimen as male, but only the latter identifies it as an adult. Only one name source is mentioned, Phillippi & Landbeck on the underside. Its catalogue number is 3, and wrongly labelled at the label and in Schlegel 1866. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Yellow-billed Teal *Anas flavirostris flavirostris* Vieillot 1816 [RMNH.AVES.231105]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1866; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Anas* Cat nº2 / ~~*Nettion*~~ / *flavirostris* / (Vieillot) / ♀ / Abbott coll: / Frank 1860 / Falkland eilanden.

Pedestal underside: [one hand] *Anas flavirostris* Vieillot / Cat 4 / ♀ / Capt Abbot / Frank 1860 / Falkland.

Schlegel 1866 (Tome VI, 31: 59): *Anas flavirostris*, Cat 2, Femelle adultes, iles Falkland, voyage de Mr. Abbot, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1866 differ. The label, underside, and Schlegel 1866 all identify the specimen as female, but only the latter identifies it as an adult. At the underside cat 4 is mentioned, this is incorrect, it's 2. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Yellow-billed Teal *Anas flavirostris flavirostris* Vieillot 1816 [RMNH.AVES.231106]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1866.

Pedestal label: [two hands] *Anas* Cat n°3 / ~~*Nettion*~~ / *flavirostris* / Vieillot / ad. / Frank 1861 / Falkland eilanden.

Pedestal underside: [one hand] *Anas flavirostris* / Vieillot / Cat N°5 / Frank / 1861 / Falkland.

Schlegel 1866 (Tome VI, 31: 59): *Anas flavirostris*, Cat 3, Individu des iles Falkland, 1861.

Remark: The collection site on the label, underside and in Schlegel 1866 differ. The label only notices the ageing. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433). Only Schlegel's handwriting appears under the base of the pedestal.

Podicipedidae

White-tufted Grebe *Rollandia rolland rolland* (Quoy & Gaimard, 1824) [RMNH.AVES.107453]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♂. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1867. (Figs 1, 2)

Pedestal label 1: [one hand] Cat n°1 / *Podiceps rollandi* / Gould / ♂ / Falkland eilanden.

Pedestal label 2: [one hand] *Podiceps Rollandii* / ♂. ad: Cat: 1 / Malouines.

Tag: [one hand] *Podiceps rollandii* ♂ / Cat. N°1 / Malouines.

Pedestal underside: [one hand] *Podiceps rollandii* ♂ / Less Uran pl 36 / Cat N° 1 / Grébe roland / Malouines.

Schlegel 1867 (Tome VI, 33: 42): *Podiceps rollandii*, Cat 1, Mâles adultes, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. One label has adult and the other has male, the latter applies also for the underside. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433). One specimen is missing from HMS *Beagle* (Steinheimer 2004). Only Schlegel's handwriting appears under the base of the pedestal.

White-tufted Grebe *Rollandia rolland rolland* (Quoy & Gaimard, 1824) [RMNH.AVES.107454]. Loc: Falklands

Fig. 1. White-tufted Grebe *Rollandia rolland rolland* (RMNH.AVES.107453), collected Falklands, by C.C. Abbott (photograph by Justin Jansen, 18 December 2012; © Naturalis Biodiversity Center, Leiden).

(*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♂. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Schlegel 1867.

Pedestal label 1: [one hand] Cat n°2 / *Podiceps rollandi* / Gould / ♂ / Frank / Falkland eilanden.

Pedestal label 2: [one hand] *Podiceps Rollandii* / ♂ ad: Cat 2 / Malouines.

Pedestal underside: [one hand] *Podiceps rollandii* ♂ / Uranie pl 36 / Cat N° 2 / Grébe rolland / Par Frank / Malouines. Het oude ♀ (unreadable / (unreadable) / oude ♂.

Schlegel 1867 (Tome VI, 33: 42): *Podiceps rollandii*, Cat 2, Mâles adultes, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The label, underside, and Schlegel 1866 all identify the specimen as male, but only the latter identifies it as an adult, but also at the underside it is identified as adult ♀. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). One specimen is missing from HMS *Beagle* (Steinheimer 2004). Only Schlegel's handwriting appears under the base of the pedestal.

White-tufted Grebe *Rollandia rolland rolland* (Quoy & Gaimard, 1824) [RMNH.AVES.107455]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: ex-

Fig. 2. White-tufted Grebe *Rollandia rolland rolland* (RMNH.AVES.107453), Pedestal underside (photograph by Justin Jansen, 18 December 2012; © Naturalis Biodiversity Center, Leiden).

tant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859, Schlegel 1867; Sclater 1860, 1861, 1862.

Pedestal label 1: [one hand] Cat n°3 / *Podiceps rollandi* / Gould / ♀ / Capt Abbot / Stanley / 1859 / O. Falkland eilanden.

Pedestal label 2: [one hand] *Podiceps Rollandii* / ♀ ad: Cat: 3. île orientale des / Malouines / Mr Abbot Stanley / 1859.

Tag: [one hand] *Podiceps rollandii* / ♀ Cat. N° 3 / Capt. Abbot Stanley / 1859 / Oost Falkland.

Pedestal underside: [one hand] *Podiceps rollandii* / ♀ / Cat N° 3 / Capt. Abbot Stanley / 1859 / Oost Falkland.

Schlegel 1867 (Tome VI, 33: 42): *Podiceps rollandii*, Cat 3, Femelle adulte, absolument semblable au ♂ adulte; île orientale des Malouines. Voyage de Mr. Abbot Standley, acquise en 1859.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The labels, tag, underside, and Schlegel 1867 all identify the specimen as female, but only the latter and one of the labels identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Southern Silvery Grebe *Podiceps occipitalis occipitalis* Garnot, 1826 [RMNH.AVES.107612]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: ♂. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1867.

Pedestal label 1: [two hands] *P. o. occipitalis* Garnot. Cat n°1 / *Podiceps calipareus* / Less. / ♂ / Frank / Falkland eilanden.

Pedestal label 2: [one hand] *Podiceps occipitalis* / ♂ Cat: 1 / Malouines.

Tag: [one hand] *Podiceps occipitalis*. cat 1. Frank. Malouines.

Pedestal underside: [one hand] *Podiceps occipitalis* / ~~*calipareus* ♂~~ / Less. Coquille pl 4 / Cat. 1 / Grebe aux belles joues / p. Frank / Malouines.

Schlegel 1867 (Tome VI, 33: 41): *Podiceps occipitalis*, Cat 1, ♂ au plumage parfait, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The labels, tag, underside, and Schlegel 1867 all identify the specimen as male, but only the latter identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433). One specimen is missing from HMS *Beagle* (Steinheimer 2004). Only Schlegel's handwriting appears under the base of the pedestal.

Southern Silvery Grebe *Podiceps occipitalis occipitalis* Garnot, 1826 [RMNH.AVES.107609]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: November–December 1822. Col: voyage *La Coquille*, R.P. Lesson / P. Garnot. Age/sex: adult ♀. Acq: April 1825 received in exchange with the Paris Museum. Status: extant, ac-

cessed 18 December 2012. Tax: mounted. Pub: Lesson & Garnot 1826–1830; Schlegel 1867.

Pedestal label 1: [two hands] *P.o. occipitalis* Garnot Cat: nº2 / *Podiceps calipareus* / Less. / ♀ April 1825 Falkland eilanden.

Tag: [one hand] *P occipitalis* ♀ / Cat No2 / April 1825 / Malouines.

Pedestal underside: [two hands] *Podiceps occipitalis* / ~~*Podiceps calipareus*~~ / ♀ / Less. / Grèbe aux belles Joues / Les Coquille pl 45 / Cat 2 / Avril 1825 Avril 1825. / Malouines.

Schlegel 1867 (Tome VI, 33: 41): *Podiceps occipitalis*, Cat 2, Femelle au plumage parfait, absolument semblable aux males en parure, tuee en Avril 1825, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The label, tag, underside, and Schlegel 1867 all identify the specimen as female, but only the latter identifies it as an adult. Its origin could be traced from one of the acquisition books in MNHN, that clearly shows the exchange of this bird to Temminck in April 1825.

Southern Silvery Grebe *Podiceps occipitalis occipitalis* Garnot, 1826 [RMNH.AVES.107610]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in 1858. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859, Schlegel 1867; Sclater 1860, 1861, 1862.

Pedestal label 1: [two hands] *P. o. occipitalis* Garnot Cat nº3 / *Podiceps calipareus* / Less. / ♂ / Kapt: Abbot / Stanley 1859 / Oost-Falkland.

Pedestal label 2: [one hand] *Podiceps occipitalis* / 1859 ♂. Cat: 3. Iîe orient des, / / Voy. Abbot Stanly / Malouines.

Tag: [one hand] *Podiceps occipitalis* / ♂ Cat 3 / Capt Abbot Stanley / 1859 / Oost-Falkland.

Pedestal underside: [two hands] *Podiceps occipitalis* / ♂ / Cat 3 / Capt. Abbot Stanley / 1859 / Oost-Falkland.

Schlegel 1867 (Tome VI, 33: 41): *Podiceps occipitalis*, Cat 3, ♂ au plumage parfait, ile orientale des Malouines, voyage de Mr. Abbot Stanley, acquis en 1859.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The labels, tag, underside, and Schlegel 1867 all identify the specimen as male, but only the latter identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Spheniscidae

King Penguin *Aptenodytes patagonicus* J.F. Miller, 1778 [RMNH.AVES.107287]. Loc: –. Date: –. Col: –. Age/sex: adult. Acq: from the Paris museum. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1867.

Pedestal label: [one hand] Cat nº1 / *Aptenodytes patachonica* / Forster / 1835 / Falkland eilanden.

Pedestal underside: [one hand] *Aptenodytes patachonica* / Cat No1 / Paris 1835 / Malouines.

Schlegel 1867 (Tome VI, 33: 5–6): Adulte, Malouines, voyage de *l'Astrolabe* et de la *Zelee*.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The ageing is only present in Schlegel 1867. Either the date 1835 is incorrect or the expedition where it is collected. Only Schlegel's handwriting appears under the base of the pedestal.

If voyage de *l'Astrolabe* et de *la Zelee* is correct: Possibly collected at Ciudad del Rey Don Felipe or elsewhere in the straits of Patagonia, Chile (not the Falklands). Col: collected at the expeditions with the Astrolabe and Zélée, Jacques Bernard Hombron or Honore Jacquinot. Date: December 1836–January 1837. Sex/age: Adult. Acquisition: from the Paris museum in 1842.

If 1835 is correct: Loc: Falklands (51°45'S 59°00'W). Col: voyage *La Coquille*, P. Lesson / P. Garnot. Date: November–December 1822. Sex/age: adult. Acquisition: June 1835 received in exchange with the Paris Museum.

King Penguin *Aptenodytes patagonicus* J.F. Miller, 1778 [RMNH.AVES.107286]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: November–December 1822. Col: voyage *La Coquille*, P. Lesson / P. Garnot. Age/sex: adult. Acq: June 1835 received in exchange with the Paris Museum. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Lesson & Garnot 1826–1830; Schlegel 1867.

Pedestal label: [one hand] Cat nº.2 / *Aptenodytes patachonica* / Forster / Falkland eilanden.

Pedestal underside: [one hand] *Spenicurus Pennantii* / Cat nº 2 / Iles Malouines.

Schlegel 1867 (Tome VI, 33: 3): *Spenicurus pennantii*, Cat 2, Adulte, Iles Malouines, acquis en 1835.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The ageing is only present in Schlegel 1867. Notable is the lack of the note appearing in Schlegel 1867 that it was purchased in 1835, this is missing from both label as underside. Only Schlegel's handwriting appears under the base of the pedestal.

King Penguin *Aptenodytes patagonicus* J.F. Miller, 1778 [–]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult. Acq: –. Status: non-extant, not found. Tax: –. Pub: Schlegel 1867.

Schlegel 1867 (Tome VI, 33: 3): *Spenicurus pennantii*, Cat 2, Adulte, Malouines.

Remark: Little information is available.

Gentoo Penguin *Pygoscelis papua papua* (J.R. Forster, 1781) [RMNH.AVES.107252]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1867.

Pedestal label: [one hand] Cat nº1 / *Pygoscelis papua* / (Forster) / Falkland eilanden.

Pedestal underside: [one hand] *Spheniscus papua* / *Aptenodytes papuaensis* / Cat 1 / Manchot (unreadable) Sonner. Pl 115 / (unreadable) parfaite / Par Frank / Iles Falkland / Malouines.

Schlegel 1867 (Tome VI, 33: 5): *Sphenicurus papua*, Cat 1, Adulte, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The ageing is only present in Schlegel

1867. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH. AVES.230433). Only Schlegel's handwriting appears under the base of the pedestal.

Gentoo Penguin *Pygoscelis papua papua* (J.R. Forster, 1781) [RMNH.AVES.107253]. Loc: Possibly collected at Ciudad del Rey Don Felipe or elsewhere in the straits of Patagonia, Chile (not the Falklands). Date: December 1836–January 1837. Col: collected at the expeditions with the Astrolabe and *Zélée*, Jacques Bernard Hombron or Honore Jacquinot. Age/sex: adult ♀. Acq: from the Paris museum in 1842. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Blanchard et al. 1854; Schlegel 1867.

Pedestal label: [one hand] Cat nº2 / *Pygoscelis papua* / (Forster) / ♀ / Falkland eilanden.

Pedestal underside: [two hands] *Spheniscus papua* / *Aptenodytes papuaensis* ♀ / ♀ / Sonnerat / Cat 2 / Voyage *Astrolabe* / Voy *Astrolabe* a *Zelee* / Malouines / Malouines.

Schlegel 1867 (Tome VI, 33: 5): *Sphenicurus papua*, Cat 2, Femelle adulte, Malouines, voyage de *l'Astrolabe* et de la *Zelee*.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The sexing of the specimen is noted in all sources, the ageing however is only present in Schlegel 1867. The label, underside, and Schlegel 1867 all identify the specimen as female, but only the latter identifies it as an adult. Two name sources are mentioned, Forster on the label and Sonnerat on the underside. Arrived in 1842 from the Paris Museum (part on exchange between Temminck and Paris).

Chinstrap Penguin *Pygoscelis antarcticus* (J.R. Forster, 1781) [RMNH.AVES.107250]. Loc: Possibly collected at Ciudad del Rey Don Felipe or elsewhere in the straits of Patagonia, Chile (not the Falklands). Date: December 1836–January 1837. Col: collected at the expeditions with the *Astrolabe* and *Zélée*, Jacques Bernard Hombron or Honore Jacquinot. Age/sex: adult. Acq: from the Paris museum in 1842. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Blanchard et al. 1854; Schlegel 1867.

Pedestal label: [one hand] Cat nº1 / *Pygoscelis antarctica* / (Forster) / Falkland eilanden.

Pedestal underside: [one hand] *Sphenicurus antarctica* / ~~Miller pl 40~~ / (unreadable crossed) / Cat 1 / (unreadable crossed) / M Paris Astrolabe et de Zelee / (unreadable) / Regiones Antarcticues / Malouines.

Schlegel 1867 (Tome VI, 33: 5–6): Adulte, Malouines, voyage de *l'Astrolabe* et de la *Zelee*.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. Only in Schlegel 1867 the specimen is aged. Arrived in 1842 from the Paris Museum (part on exchange between Temminck and Paris Museum). Only Schlegel's handwriting appears under the base of the pedestal.

Macaroni Penguin *Eudyptes chrysolophus* J.F. von Brandt, 1837 [RMNH.AVES.107247]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1867.

Pedestal label: [two hands] *Eudyptes chrysolophus* (Brandt) Cat. nº1 / *Catarrhactes chrysolophus* / Brandt / ♂ / Frank / Falkland Eilanden.

Pedestal underside: [three hands] *Spheniscus diamematus* / ~~*chrysolophus*~~ / ♂ adult / Gould Proc an 1837 p 3 / *Aptenodytes cirhata* Miller pl (unreadable) / Cat 1 / pr Frank / (line unreadable) / Bec rouge (two unreadable words) / Iles Falkland.

Schlegel 1867 (Tome VI, 33: 8): Adulte, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The label, underside, and Schlegel 1867 all identify the specimen as male, but only the latter identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433).

Fjordland Penguin *Eudyptes pachyrhynchus* G.R. Gray, 1845 [RMNH.AVES.107258]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1867.

Pedestal label: [two hands] *Eudyptes pachyrhynchus* Cat. nº2 / G.R. Gray / *Catarrhactes pachyrhynchus* / (G.R. Gray) / Falkland eilanden.

Pedestal underside: [one hand] (unreadable) Gould / *Sphenicurus chrysocome* / ~~unreadable~~ / Cat 2 / Gould Proc 1857 p 310. / (unreadable)/ île Falkland.

Pedestal underside sticker: Un très vieil et bel individu de la Nouv. Zél., et appartenant à M. Frank est d'une taille un peu plus forte, le bec est plus grand et les teintes foncées sont d'un noir plus intense, Schlegel.

Schlegel 1867 (Tome VI, 33: 6–7): Adulte, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. Ageing only present in Schlegel 1865, note the different Latin names. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433).

Fjordland Penguin *Eudyptes pachyrhynchus* G.R. Gray, 1845 [RMNH.AVES.107249]. Loc: Beauchene Island, Falkland (*ca.* 52° 53′ 11″ S, 59° 12′ 13″ W). Date: –. Col: –. Age/sex: adult. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1867.

Pedestal label: [two hands] *Eudyptes pachyrhynchus* Cat nº.3 / (G.R. Gray) / *Catarrhactes pachyrhynchus* / (G.R. Gray) / Beauchene / Frank, 1861 / Falkland eilanden.

Pedestal underside: [three hands] *Spheniscus chrysolophus* / (unreadable) in Gould / Cat nº2 / île Beauchesne / Frank 1861 / Malouines.

Pedestal underside sticker: Bought from Beauchene / island by the sealers / Frank 1861 [two hands].

Schlegel 1867 (Tome VI, 33: 7): *Spheniscus chrysolophus*, Cat 2, Albinos, rapporte de l'ile Beachene, Malouines, 1861.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. The origin is only documented at the label (Frank). The bird was acquired through the Amster-

dam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433).

Magellanic Penguin *Spheniscus magellanicus* J.R. Forster, 1781 [RMNH.AVES.107261]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1867.

Pedestal label: [one hand] Cat nº2 / *Spheniscus ~~demersus~~* / *magellanicus* / (Forster) / Frank / Falkland eilanden.

Pedestal underside: [one hand] *Spheniscus demersus* / Cat N 4 / Nov spec! = *Apt. demersa* var C. Vieillot / Finsch / ex Pernetti Voy aux iles Malouines II p 17 / Pernetti, P. / Frank / Iles Malouines.

Schlegel 1867 (Tome VI, 33: 10–12): *Spheniscus demersus*, Cat 4, Individu au passage à la livrée parfaite, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. Frank is missing from Schlegel. Finsch thought it was a new species for science. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433). Only Schlegel's handwriting appears under the base of the pedestal.

Magellanic Penguin *Spheniscus magellanicus* J.R. Forster, 1781 [RMNH.AVES.107262]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: Adult. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1867.

Pedestal label: [one hand] Cat nº3 / *Spheniscus ~~demersus~~* / *magellanicus* / (Forster) / Frank / Falkland eilanden.

Pedestal underside: [one hand] sp nov. (unreadable) Finsch / Black-footed Penguin (unreadable) / *Spheniscus demersus* / Cat Nº.5 / Via Frank / Malouines.

Schlegel 1867 (Tome VI, 33: 10–12): *Spheniscus demersus*, Cat 5, Individu au plumage imparfait, mais offerant la taille des adultes, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1867 differ. Notable if difference in Latin names at the label and underside, the latter is in line with Schlegel 1867. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH. AVES.230433).

Procellariidae

Slender-billed Prion *Pachyptila belcheri* Mathews, 1912 [RMNH.AVES.107095]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: February 1860. Col: –. Age/sex: –. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1863b.

Pedestal label: [one hand] Cat.nº2 / *Prion ariel* / Gould / Februari 1860 / Frank 1863 / Falkland eilanden.

Pedestal underside: [one hand] *Procellaria ariel* Gould / *Fr. turtur* Kuhl, Dser, p 143, pl8 / Cat Nº2 / February 1860 / Falkland Island / Frank / 1863.

Schlegel 1863b (Tome VI, 22: 18): Individu des Mers de l'Australie, obtenus en 1863 de Mr Gould.

Remark: The collection site on the label, underside and in Schlegel 1867 differ, and two birds are involved (Schlegel 1863b: 22). Notable is the lack of catalogue number in Schlegel 1863b. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433). A specimen is missing from HMS *Beagle* (Steinheimer 2004). Only Schlegel's handwriting appears under the base of the pedestal.

Phalacrocoracidae

Rock Shag *Phalacrocorax magellanicus* J.F. Gmelin, 1789 [RMNH.AVES.107973]. Loc: Magdalena Island (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♂. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1863a.

Pedestal label: [two hands] *Phalacrocorax magellanicus* / *Graculus magellanicus* / m. Cat Nº 1 / Malouines.

Pedestal underside: [one hand] *Graculus / Carbo magellanicus* ♂ / Forster voy / Cat No 1 / Frank / Ile Magdalena / Malouines.

Schlegel 1863a (Tome VI, 21: 21): *Graculus magellanicus*, Cat 1, ♂ adulte, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1863a differ. Ageing only appears in Schlegel 1853a as aged and sexed. Due to the remark of Magdalena Island (52°55'S 70°35'W) on the pedestal underside, the known expedition that visited this place was the voyage de *l'Astrolabe* et de *la Zelee* and could be the source. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433). Only Schlegel's handwriting appears under the base of the pedestal.

Rock Shag *Phalacrocorax magellanicus* J.F. Gmelin, 1789 [RMNH.AVES.107972]. Loc: Magdalena Island (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♀. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1863a.

Pedestal label: [two hands] *Phalacrocorax magellanicus* / *Graculus magellanicus* / f. Cat Nº 2 / Malouines.

Tag: [one hand] *Graculus magellanicus* / Cat: No 2 ♀ / Frank. Malouines.

Pedestal underside: [one hand] *Graculus* / *Carbo magellanicus* / Forster voy / Cat Nº 2 / Frank / Malouines.

Note Pedestal label: [one hand] Ile Magdalena / (unreadable) / le brun / (unreadable) orange / (unreadable).

Schlegel 1863a (Tome VI, 21: 21): *Graculus magellanicus*, Cat 2, Femelle adulte, Malouines.

Remark: The collection site on the label, underside and in Schlegel 1863a differ. The tag, and Schlegel 1863a all identify the specimen as female, but only the latter identifies it as an adult. Due to the remark of Magdalena Island (52°55'S 70°35'W) on the pedestal underside, the known expedition that visited this place was the voyage de *l'Astrolabe* et de *la Zelee* and could be the source. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433). Only Schlegel's handwriting appears under the base of the pedestal.

Rock Shag *Phalacrocorax magellanicus* J.F. Gmelin, 1789 [RMNH.AVES.107971]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in 1860. Col: C.C. Abbott. Age/sex: ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1863a; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Phalacrocorax magellanicus* / *Graculus magellanicus* / m. Cat N°3 / voy. Cap. Abbot / 1861 / Malouines.

Tag: [one hand] *Graculus magellanicus* / ♂ Cat.3 / Abbot / Frank 1861 / Oost-Falkland.

Pedestal underside: [one hand] *Graculus magellanicus* / ♂ / Cat N°3 / Abbot / Frank 1861 / Oost-Falkland.

Schlegel 1863a (Tome VI, 21: 21): *Graculus magellanicus*, Cat 3, Male, habit de passage, ile orientale des Malouines, voyage du captaine Abbot, acquis en 1861.

Remark: The name giving of the location of collecting is differs. The label, underside, and Schlegel 1866 all identify the specimen as male, but is not present at the label. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 21 April 1861 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Chionidae

Snowy Sheathbill *Chionis albus* J.F. Gmelin, 1789 [RMNH.AVES.223734]. Loc: –. Date: –. Col: –. Age/sex: –. Acq: –. Status: extant, accessed 11 February 2013. Tax: skin. Pub: –.

Tag: [one hand] Kat.No1. Ad / *Chionis alba* (Gml) – Cat. Br. M. XXIV. p 710 / Tem.Pl.col.509 (not Type) / "Falkland Islands" / No origin! / "Nouv.Zelande 'Temmik" / "Chatham Isl. Schlegel.

Tag (Backside): [one hand] *Chionis vaginalis*, Forst. *-vaginalis* / *alba*, Sull, – bec en foureau blanc / Tem. Pl. Col 509. Nouv Zelande "old / label written by Temminck".

Pedestal underside: removed.

Remark: Due to two different locations mentioned on the tag, is uncertain if the specimen was collected at either "New Zealand", "Chatham Islands" or the "Falklands". The bird was skinned after first been mounted, the information on the pedestal underside and the label is not contained. Possibly this was transcribed on the tag by Otto Finsch.

Haematopodidae

Magellanic Oystercatcher *Haematopus leucopodus* Garnot, 1826 [RMNH.AVES.224449]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1865; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Haematopus luctuosus* / ad. Cat: 1 / îles Malouines.

Pedestal underside: [one hand] *Haematopus* (unreadable and crossed) / (3 words unreadable and crossed) / *luctuosus* Cuv / Frank / Cat. N°1 / Malouines.

Schlegel 1865 (Tome IV, 29:74): *Haematopus luctuosus*, Cat 1, Adulte, iles Malouines.

Remark: The collection site on the label, underside and in Schlegel 1865 differ. Both the underside and Schlegel 1866 identify the specimen as female, but only the latter identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433), note the source is only present at the underside. Only Schlegel's handwriting appears under the base of the pedestal.

Magellanic Oystercatcher *Haematopus leucopodus* Garnot, 1826 [RMNH.AVES.224449]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1865; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Haematopus luctuosus* / ad. Cat: 2. Ile Orient des / Malouines / Mr Abbot Stanley / 1860.

Pedestal underside: [one hand] *Haematopus luctuosus* / Cat. N°2 / Capt / Abbot Stanley / 1860 / Oost-Falkland.

Schlegel 1865 (Tome IV, 29:74): *Haematopus luctuosus*, Cat 2, Adulte, ile orientale des Malouines, voyage du Capitaine Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1865 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. Both the label and Schlegel 1865 identify the specimen as adult, it lacks at the underside. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Charadriidae

Two-banded Plover *Charadrius falklandicus* Latham, 1790 [RMNH.AVES.223949]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1865.

Pedestal label: [one hand] *Charadrius falklandicus* / Ad Cat 1 / Malouines.

Pedestal underside: [one hand] *Charadrius falklandicus* / Lath / (unreadable words) / pr Frank Cat N1 / Malouines.

Schlegel 1865 (Tome IV, 29: 36): *Charadrius falklandicus*, Cat 1, Adulte, Malouines.

Remark: The ageing however is absent on the underside. Handwriting from Temminck indicates an old specimen, possible secured due to one of the exchanges with the Parisian Museum. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433), note the source is only present at the

underside. Only Schlegel's handwriting appears under the base of the pedestal.

Two-banded Plover *Charadrius falklandicus* Latham, 1790 [RMNH.AVES.223954]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1865; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Charadrius falklandicus* / ♂ ad. Cat: 2 / Abbot Stanley / 1860 / Ile orient des / Malouines.

Pedestal underside: [one hand] *Charadrius* / *falklandicus* / ♂ / Cat N°2 / Capt / Abbot Stanley / 1860 / Oost Falkland.

Schlegel 1865 (Tome IV, 29: 36): *Charadrius falklandicus*, Cat 2, ♂ adult, ile orientale des Malouines, voyage du Capitaine Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1865 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The label, underside, and Schlegel 1866 all identify the specimen as male, but only label and Schlegel identifies it as an adult ♂. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Two-banded Plover *Charadrius falklandicus* Latham, 1790 [RMNH.AVES.223955]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1865; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Charadrius falklandicus* / 1860. ♀ ad Cat: 3 / Ile orient des / Abbot Stanley / Malouines.

Pedestal underside: [one hand] *Charadrius* / *falklandicus* / ♀ / Cat N° 3 / eye black / Capt. Abbot / Stanley / 1860 / Oost Falkland.

Schlegel 1865 (Tome IV, 29: 36): *Charadrius falklandicus*, Cat 3, ♀ adult, ile orientale des Malouines, voyage du Capitaine Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1865 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The label, underside, and Schlegel 1866 all identify the specimen as female, but only the label and Schlegel identifies it as an adult ♀. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Rufous-chested Plover *Charadrius modestus* M.H.C. Lichteinstein, 1823 [RMNH.AVES.226062]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1865; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Morinellus modestus* / ♂ Cat: 1 / Ile Orients des / M[r] Abbot Stanley / 1860 / Malouines.

Pedestal underside: [one hand] *Morinellus modestus* / ♂ / Cat N°1 / Capt. / Abbot Stanly / 1860 / Oost Falkland.

Schlegel 1865 (Tome IV, 29: 48): *Morinellus modestus*, Cat 1, ♂ au plumage parfait, ile orientale des Malouines, voyage de Mr. Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1865 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The label, underside, and Schlegel 1865 all identify the specimen as male, but only the latter identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Rufous-chested Plover *Charadrius modestus* M.H.C. Lichteinstein, 1823 [RMNH.AVES.226063]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1865; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Morinellus modestus* / ♀ Cat: 2 / île Orients des / Mr. Abbot Stanley / 1860 / Malouines.

Pedestal underside: [one hand] *Morinellus modestus* / ♀ Vat. N° 2 / eye black / Capt. / Abbot Stanly / 1860 / Oost falkland.

Schlegel 1865 (Tome IV, 29: 48): *Morinellus modestus*, Cat 2, ♀ au plumage parfait, ile orientale des Malouines, voyage de Mr. Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1865 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The label, underside, and Schlegel 1865 all identify the specimen as female, but only the latter identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Southern Lapwing *Vanellus chilensis chilensis* (Molina, 1782*)* [RMNH.AVES.31529]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: –. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1865; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *occidentalis* Cat 7 / *Vanellus ~~cayennensis~~* / ad. cat. ~~9~~ / Île orientale des / Mr. Abbot Stanley / 1860 / Malouines.

Pedestal underside: [one hand] *Vanellus cayennensis* / Capt. / Cat. N° 9 / Abbot Stanley / 1860 / Oostfalkland.

Schlegel 1865 (Tome IV, 29: 57–58): *Vanellus cayennensis*, Cat 9, Adulte a tarses seulement longs de 2 pouces, ile orientale des Malouines, voyage de Mr Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1865 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Thinocoridae

Least Seedsnipe *Thinocorus rumicivorus rumicivorus* Eschscholtz, 1829 [RMNH.AVES.87538]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 11 February 2013. Tax: mounted (syntype). Publ: Abbott 1860, 1861; Gould 1859; Sclater 1860, 1861, 1862.

Pedestal label: not present.

Pedestal underside: [one hand] Cat. 5 / ♂ / 1860 / Capt / Abbot Stanley / Oost Falkland.

Remark: The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Scolopacinae

Hudsonian Godwit *Limosa haemastica* Linnaeus, 1758 [RMNH.AVES.31529]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1864; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Limosa hudsonica* / 1860 ♂ Cat: 1 / Capt.ne Abbot. Ile Or des Malouines.

Pedestal underside: [one hand] *Limosa hudsonica* / Cat 1 / ♂ / Cap / Abbot Stanley / Oost Falkland.

Schlegel 1864 (Tome V, 27: 22–23): *Limosa hudsonica*, Cat 1, ♂ au plumage parfait de noces, ile orientale des Malouines, voyage du Capitaine Abbot, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1864 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The label, underside, and Schlegel 1864 all identify the specimen as male, but only the latter identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

White-rumped Sandpiper *Calidris fuscicollis* Vieillot, 1819 [RMNH.AVES.223070]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: –. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 11 February 2013. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1864; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Tringa Bonapartei* / Cat. ~~10~~ 6 / Stanley 1860 / Malouines.

Pedestal underside: [two hands] *Tringa Bonapartei* / Cat N° 10 / Capt / Abbott Stanley / 1860 / Oost Falkland.

Schlegel 1864 (Tome V, 27: 43–43): *Tringa bonapartei*, Cat 10, Individu dans la livrée d'hiver. Tués dans l'ile orientale des Malouines voyage du Capitaine Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1864 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

White-rumped Sandpiper *Calidris fuscicollis* Vieillot, 1819 [RMNH.AVES.220882]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: Adult. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 11 February 2013. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1864; Sclater 1860, 1861, 1862.

Pedestal Label: [two hands] *Tringa Bonapartei* / Cat. ~~11~~ 7 / Stanley 1860. Malouines.

Pedestal underside: [two hands] *Tringa / Bonapartei* / Cat N° 11 / Abbot / 1860 / Iles Falkland.

Schlegel 1864 (Tome V, 27: 43–43): *Tringa bonapartei*, Cat 11, Individu dans la livrée d'hiver. Tués dans l'ile orientale des Malouines voyage du Capitaine Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1864 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

White-rumped Sandpiper *Calidris fuscicollis* Vieillot, 1819 [RMNH.AVES.220883]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: –. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 11 February 2013. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1864; Sclater 1860, 1861, 1862.

Pedestal Label: [two hands] *Tringa Bonapartei* / Cat. ~~12~~ 8. / Stanley 1860 / Malouines.

Pedestal underside: [one hand] *Tringa Bonapartei* / Cat. N 12. / Capt Abbott / Stanley / 1860. / OostFalkland.

Schlegel 1864 (Tome V, 27: 43–43): *Tringa bonapartei*, Cat 12, Individu dans la livrée d'hiver. Tués dans l'ile orientale des Malouines voyage du Capitaine Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1864 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

South American Snipe *Gallinago paraguaiae magellanica* Vieillot, 1816 [RMNH.AVES.220457]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1864; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Gallinago paraguaiae* / ad: Cat. 6 Ile orientalis des / Cap: Abbot Stanley. / Malouines / 1860.

Pedestal underside: [two hands] *Gallinago paraguaiae* / *Scolopax magellanica* / King / Cat. 6. /Capt. / Abbot Stanley / 1860 / Oost Falkland.

Schlegel 1864 (Tome V, 27: 11–12): *Gallinago paraguaiae*, Cat 6, Adultes, ile orientale des Malouines, voyage du Capitaine Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1864 differ. Only the underside identifies the specimen as adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

South American Snipe *Gallinago paraguaiae magellanica* Vieillot, 1816 [RMNH.AVES.220458]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1864; Sclater 1860, 1861, 1862.

Pedestal label: [two hands] *Gallinago paraguaiae* / Ad: Cat 7 / Abbot Stanley / Ile or: des: Malouines / 1860.

Pedestal underside: [two hands] *Gallinago paraguaiae* / *Scolopax magellanica* / King / Cat. 7 / Capt. / Abbot Stanly / 1860 / Oost Falkland.

Schlegel 1864 (Tome V, 27: 11–12): *Gallinago paraguaiae*, Cat 7, Adultes, ile orientale des Malouines, voyage du Capitaine Abbot Stanley, acquis en 1860.

Remark: The collection site on the label, underside and in Schlegel 1864 differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. Only Schlegel 1864 identifies the specimen as adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Laridae

Brown-hooded Gull *Chroicocephalus maculipennis* M.H.C. Lichtenstein, 1823 [RMNH.AVES.207906]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in 1858. Col: C.C. Abbott. Age/sex: adult summer-plumage. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1863c; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] Cat n°8 / *Larus glaucodes* / Meyen / Kapt. Abbot / 1859 / O. Falkland eilanden.

Pedestal underside: [one hand] *Larus glaucotis* / Cat. N°1 / Abbot Stanley / 1859 / Oostfalkland.

Schlegel 1863c (Tome VI, 23: 42): *Larus glaucotis*, Cat 1, Adulte, plumage de noces, iles Falkland, voyage du Capitaine Abbot, acquis en 1859.

Remark: The collection site on the label, underside and in Schlegel 1863c differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. Only Schlegel 1863c identifies the specimen as adult. Erroneously at the label are mentioned Catalogue number 8 (=1). The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Brown-hooded Gull *Chroicocephalus maculipennis* M.H.C. Lichtenstein, 1823 [RMNH.AVES.207908]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♂ summer-plumage. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Schlegel 1863c.

Pedestal label: [one hand] cat: n°9 / *Larus glaucodes* / Meyen / Frank / Falkland eilanden.

Pedestal underside: [one hand] *Larus glaucotis* / Cat N°2 / Par Frank / Falkland.

Schlegel 1863c (Tome VI, 23: 42): *Larus glaucotis*, Cat 2, ♂ au plumage de noces, iles Falkland.

Remark: The collection site on the label, underside and in Schlegel 1863c differ. Only Schlegel 1863c identifies the specimen as adult ♂. Erroneously at the label is mentioned Catalogue number 9 (=2). The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433). Only Schlegel's handwriting appears under the base of the pedestal.

Brown-hooded Gull *Chroicocephalus maculipennis* M.H.C. Lichtenstein, 1823 [RMNH.AVES.207910]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♂ summer-plumage. Acq: –. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Schlegel 1863c.

Pedestal label: [one hand] Cat n°10 / *Larus glaucodes* / Meyen / ♂ / Falkland eilanden.

Pedestal underside: [one hand] *Larus glaucotes* ♂ / Meyen / (unreadable 3 words) / Cat N°3 / Iles Falkland.

Schlegel 1863c (Tome VI, 23: 42): *Larus glaucotis*, Cat 3, ♂ au plumage de noces, iles Falkland.

Remark: The collection site on the label, underside and in Schlegel 1863c differ. The label and Schlegel 1863c identify the specimen as male.
Only Schlegel's handwriting under the base of the pedestal. Erroneously at the label is mentioned Catalogue number 11 (=4). Only Schlegel's handwriting at the base of the pedestal.

Brown-hooded Gull *Chroicocephalus maculipennis* M.H.C. Lichtenstein, 1823 [RMNH.AVES.207912]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♀ summer-plumage. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Schlegel 1863c.

Pedestal label: [one hand] Cat nº 11 / *Larus glaucodes* / Meyen / Falkland eilanden.
Pedestal underside: [two hands] *glaucotus* / *Larus / glaucotes* / Cat Nº 4 / Meyen / (unreadable)/ Frank / ~~Malouines~~ / Malouines.
Schlegel 1863c (Tome I, 32: 42): *Larus glaucotis*, Cat 4, Femelle adulte, iles Falkland.
Remark: The collection site on the label, underside and in Schlegel 1863c differ. Only Schlegel 1863c identifies the specimen as adult. Erroneously at the label is mentioned Catalogue number 11 (=4). Temminck and Schlegel handwriting at the base of the pedestal.

Dolphin Gull *Leucophaeus scoresbii* Traill, 1823 [RMNH.AVES.206067]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult plumage. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1863c; Sclater 1860, 1861, 1862.
Pedestal label: [one hand] cat: nº 1. / *Larus scoresbii* / Traill. / Capt. Abbot / 1860 / Falkland eil.
Pedestal underside: [two hands] *scoresbii* Traill. / *Larus haematorhynchus* / Cat Nº1 / feet a beak coral red / pupil white / Capt Abbot / 1860 / Oost-Falkland.
Schlegel 1863c (Tome VI, 23: 33–34): *Larus scoresbyi*, Cat 1, Adulte, iles Falkland, voyage du Captaine Abbot, 1860: bec et pieds rouge de corail, iris de l'oeil blanc (Abbot).
Remark: The collection site on the label, underside and in Schlegel 1863c differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. Only Schlegel 1863c identifies the specimen as adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Dolphin Gull *Leucophaeus scoresbii* Traill, 1823 [RMNH.AVES.206069]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: Immature ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1863c; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] cat. nº.2 / *Larus scoresbii* / Traill / ♂ / Capt Abbot / Frank 1861 / Falkland eil.
Pedestal underside: [two hands] *scoresbii* Traill. / *Larus haematorhynchus* (unreadable) / ♂ / Jeugdig kleed in / overgang naar het vol- / wassen kleed / Cat. Nº2. / Reis van / Capt. Abbot / Frank 1861 / O. Falkland.
Schlegel 1863c (Tome VI, 23: 33–34): *Larus scoresbyi*, Cat 2, ♂ en passage, meme origine que le No 1.
Remark: The collection site on the label, underside and in Schlegel 1863c differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 12 May 1861 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott).

Kelp Gull *Larus dominicanus dominicanus* M.H.C. Lichtenstein, 1823 [RMNH.AVES.207350]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂ summer-plumage. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Publ: Abbott 1860, 1861; Gould 1859; Schlegel 1863c; Sclater 1860, 1861, 1862.
Pedestal label: [one hand] cat: nº 1. / *Larus fuscus* / *dominicanus* Licht. / ♂ / Capt: Abbot / 1860 / Oost Falkland eil.
Pedestal underside: [one hand] *Larus dominicanus* / Cat Nº 1 ♂ / Lect livid, Beak greenish yellow / Capt Abbot Stanley / 1859 / Oost Falkland.
Schlegel 1863c (Tome VI, 23: 12–13): *Larus dominicanus*, Cat 1, ♂ adultes, iles Falkland, voyage du Capitaine Abbot Stanley, acquis en 1860: pieds d'un verdatre, passant par-ci par-la au jaune.
Remark: The collection site on the label, underside and in Schlegel 1863c differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The label, underside, and Schlegel 1863c all identify the specimen as male, but only the latter identifies it as an adult. Disagreement at the label and stand on the date of acquisition. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Kelp Gull *Larus dominicanus dominicanus* M.H.C. Lichtenstein, 1823 [RMNH.AVES.207352]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1863c; Sclater 1860, 1861, 1862.
Pedestal label: [one hand] Cat nº 2 / *Larus fuscus* / *dominicanus* Licht. / ♀ / Capt Abbot / 1860 / Oost Falkland eil.
Pedestal underside: [one hand] *Larus dominicanus* / ♀ / Cat Nº 2. / 1860 / Capt Abbot / 1860 / Oost Falkland.
Schlegel 1863c (Tome VI, 23: 12–13): *Larus dominicanus*, Cat 2, Femelle adultes, iles Falkland, voyage du Capitaine Abbot Stanley, acquis en 1860: pieds d'un verdatre, passant par-ci par-la au jaune.
Remark: The collection site on the label, underside and in Schlegel 1863c differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The label, underside, and Schlegel 1863c all identify the specimen as male, but only the latter identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

South American Tern *Sterna hirundinacea* Lesson, 1831 [RMNH.AVES.209487]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: Summer plumage. Acq: –. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1863c.

Pedestal label: [one hand] Cat nº 1. / *Sterna hirundinacea* / Lesson / Falkland eilanden.
Pedestal underside: [two hands] *Sterna meridionalis* / *Sterna* / Peale / Cat nº 1 / Malouines / Malouines.
Schlegel 1863c (Tome VI, 24: 15): *Sterna meridionalis*, Cat 1, Individu au plumage de noces, iles Malouines.
Remark: The collection site on the label, underside and in Schlegel 1863c differ. Two name sources are mentioned, Lesson on the label and Peale on the underside.

Cathartidae

Turkey Vulture *Cathartes aura jota* (Molina, 1782) [RMNH.AVES.191314]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1860 or 1861. Col: C.C. Abbott. Age/sex: adult ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1862c; Sclater 1860, 1861, 1862.
Pedestal label: [one hand] Cat: nº1 / *Rhinogryphus aura* / ♀ *falklandicus* / (Sharpe) / Abbot colle.1861 / Falkland-eilanden.
Pedestal underside: [one hand] 19 *Cathartes aura* / Length from tail (unreadable) / tip of tail: 2 feet 3 inches / Broadth from tip to tip of wing, 5'2 / head & legs: pinkish flesh color / eye: dark brown) / (Capt. Abbot) / Cat Nº1 / reis van / Capt Abbot / Frank 1861 / Oost Falkland.
Schlegel 1862c (Tome VI, 10: 3–4): *Cathartes aura*, Cat 1, Femelle adulte, ile orientale des Malouines, voyage du Capitaine Abbot, 1861.
Remark: The collection site on the label, underside and in Schlegel 1862c differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. Only Schlegel 1862c identify the specimen as adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH. AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Accipitridae

Cinereous Harrier *Circus cinereus* Vieillot, 1816 [RMNH.AVES.191467]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1862d; Sclater 1860, 1861, 1862.
Pedestal label: [one hand] *Circus cinereus* / m. Cat Nº1 / par le Capitaine / Abbot 1860 / Malouines.
Pedestal underside: [one hand] 21 *Circus cinereus* / ♂ / Catal. Nº 1 / eye golden yellow / feet bright yellow / beak green, tip black / reis van / Capit. Abbot / (frank 1860) / falkland-eil.
Schlegel 1862d (Tome II, 13: 5–6)**:** *Circus cinereus*, Cat 1, ♂ au plumage parfait, ile orientale des malouines, recueilli par le Captaine Abbot, abtenu en 1860.
Remark: The collection site on the label, underside and in Schlegel 1862d differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. Only Schlegel 1862d identifies the specimen as adult ♂. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH. AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Cinereous Harrier *Circus cinereus* Vieillot, 1816 [RMNH.AVES.191468]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♀. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1862d; Sclater 1860, 1861, 1862.
Pedestal label: [one hand] *Circus cinereus* / f. Cat Nº2 / pr Mr. Abbot / 1860 / Malouines.
Pedestal underside: [one hand] 11 *Circus cinereus* / Nº 2 / ♀ in kleur = ♂ (Abbot) / reis van / Abbot / Frank 1860 / Oost Falkland.
Schlegel 1862d (Tome II, 13: 5–6): *Circus cinereus*, Cat 2, Femelle au plumage parfait, meme origine; (la femelle adulte parfaitement semblable par ses teintes au vieux male: note du Capitaine Abbot).
Remark: The collection site on the label, underside and in Schlegel 1862d differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. Both the underside and Schlegel 1862d identify the specimen as female, but only the latter identifies it as an adult. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Cinereous Harrier *Circus cinereus* Vieillot, 1816 [RMNH.AVES.191469]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: February – March 1820. Col: *L'Uranie* Joseph Paul Gaimard / Jean René Constant Quoy. Age/sex: adult ♂. Acq: via exchanged with Paris Museum. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Freycinet et al. 1824; Schlegel 1862d.
Pedestal label: [one hand] *Circus cinereus* / m. Cat Nº3 / voy. Quoy & Gaimard, / du Musee de Paris / Malouines.
Pedestal underside: [one hand] 3 / *Circus cinereus* / *Falco histrionius* ♂ / 7 / Malouines.
Schlegel 1862d (Tome II, 13: 5–6)**:** *Circus cinereus*, Cat 3, ♂ adulte Malouines, voyage de Quoy et Gaimard, du Musee de Paris.
Remark: The underside, and Schlegel 1862d all identify the specimen as male, but only the latter identifies it as an adult. Only one name source is mentioned, Quoy & Gaimard on the label and Schlegel 1862d. Only Schlegel's handwriting appears under the base of the pedestal.

Cinereous Harrier *Circus cinereus* Vieillot, 1816 [RMNH.AVES.191473]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: March 1833 or March 1834. Col: C. Darwin. Age/sex: young ♂. Acq: via Gustav Adolph

Frank Sr. Status: extant, accessed 11 February 2013. Tax: mounted. Publ: Gould 1839; Schlegel 1862d; van Grouw & Steinheimer 2008.

Pedestal label: [one hand] *Circus cinereus* / m. Cat N°7. / voy: Darwin. / 4 Janvier 1837 / Malouines.

Pedestal underside: [one hand] N°7 / *Circus cinereus* / 20 / Jong ♂ / reis / van / Darwin / frank 1860 / 4 January 1837 / Oost. Falkland-eiland.

Schlegel 1862d (Tome II, 13: 5–6)**:** *Circus cinereus*, Cat 7, ♂ au premier plumage, tue le 4 Janvier 1837, ile orientale des Malouines, voyage C. Darwin.

Remark: The collection site on the label, underside and in Schlegel 1862d differ. The underside and Schlegel 1862d identify the specimen as young male but lacks at the label. Only Schlegel's handwriting appears under the base of the pedestal.

This bird is discussed by van Grouw & Steinheimer (2008), as the missing bird from 4 January 1837, however, all notes have been subsequently added and no original data is available on or from the specimen. Possibly at one stage the original label was present. Darwin donated at 4 January 1837 mammals and 450 birds of HMS *Beagle* expedition to the Zoological Society of London (e.g. to John Gould to described them), 34–39 specimens that are still in existence from the Society arrived in 1839, 1841 and 1856 at the British Museum. The Society's labels recorded donor's name, the acquisition date and Darwin's specimen's numbers (e.g. C. Darwin Esq, Jan 4 1837) (Steinheimer 2004).

Another notable remark we find on the underside as the specimen was reportedly purchased from Frank in 1860. The other 5 from 7 birds from HMS *Beagle* expedition in Naturalis arrived in 1863 (Steinheimer 2004, van Grouw & Steinheimer 2008). The largest numbers of birds from The Falklands were those that arrived in 1859–1863 collected by C.C. Abbott (see this paper). At 30 April 1860, a large load arrived from Abbott via Frank at Naturalis, and amongst the specimens were 3 *Circus*.

Cinereous Harrier *Circus cinereus* Vieillot, 1816 [RMNH.AVES.191476]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: young ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1862d; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Circus cinereus* / Cat N°8 / pr. Mr. le Capitaine / Abbot / 1860 / Malouines.

Pedestal underside: [one hand] 22 *Circus cinereus* / No.8 / ♂ jeugdig kleed / Abbot / Frank 1860 / Oost Falkland.

Schlegel 1862d (13: 5–6): *Circus cinereus*, Cat 7, Male, Malouines, recueilli par le Capitaine Abbot, abtenu en 1860.

Remark: The collection site on the label, underside and in Schlegel 1862d differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. Both the underside and Schlegel 1862d identify the specimen as male, but only the former identifies it as young. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Variable Hawk *Geranoaetus polyosoma polyosoma* (Quoy & Gaimard, 1824) [RMNH.AVES.191227]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1862d; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Buteo polyosoma* / m. Cat N°1 / voy. Cap. Abbot / Falkland.

Pedestal underside: [two hands] 30 *polyosoma* / ♂ *erythronotus* / eye Yellow, feet yellow / Cat N°1 / reis van / Capt Abbot / Frank 1860 / Falklands.

Schlegel 1862a (Tome II, 6: 12–13): *Buteo polyosoma*, Cat 1, ♂ au plumage parfait, mais le gris du dos montrant encore des traces tres sensibles de la teinte rousse de l'habit de passage; ile orientale de Falkland, voyage du Capitaine Abbot, obtenu en 1860: iris de l'oeil et pieds jaunes (Abott).

Remark: One generic and two specific names are cited, with the primary binomial on the label agreeing with Schlegel 1862d. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. The underside, and Schlegel 1862d identify the specimen as male, but only the latter identifies it as an adult. For information on the Amsterdam-based dealer Gustav Adolph Frank and C.C. Abbott see: Kelp Goose RMNH.AVES.230433.

Variable Hawk *Geranoaetus polyosoma polyosoma* (Quoy & Gaimard, 1824) [RMNH.AVES.191228]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: ♀. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1862d.

Pedestal label: [one hand] *Buteo polyosoma* / f. Cat N°2 / pr Mr. Frank / Falkland.

Pedestal underside: [two hands] 46. *polyosoma* / *B. erythronotus* / *Falco tricolor* ♀ d'Orbigny / voy.pl3.fig2 / Cat N°2 / pr Mr Frank / Malouines et Chili.

Schlegel 1862a (Tome II, 6: 12–13): *Buteo polyosoma*, Cat 2, Femelle, habit de passage, a manteaux et scapulaires d'un roux rouygeatre uniforme; iles Falkland, pa Mr. Frank.

Remark: The collection site on the underside differs from that in Schlegel 1862d. Only one name source is mentioned, d'Orbigny on the underside. Three generic and three specific names are cited, with the primary binomial on the label agreeing with Schlegel 1866. For information on the Amsterdam-based dealer Gustav Adolph Frank see: Kelp Goose RMNH.AVES.230433.

Variable Hawk *Geranoaetus polyosoma polyosoma* (Quoy & Gaimard, 1824) [RMNH.AVES.191229]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: ♂. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1862d.

Pedestal label: [one hand] *Buteo polyosoma* / m. Cat N°3 / pr. Mr. Frank / Falkland.

Pedestal underside: [two hands] 34. *polyosoma* / *B. erythronotus* ♀ / ♂ / Quoy / Cat N°3 / Frank / Falkland.

Fig. 3. Charles Compton Abbott label, front (Variable Hawk *Geranoaetus polyosoma*, NHMUK 1955.6-20.2413; photograph by Justin Jansen, 18 June 2015; © Natural History Museum, Tring, UK).

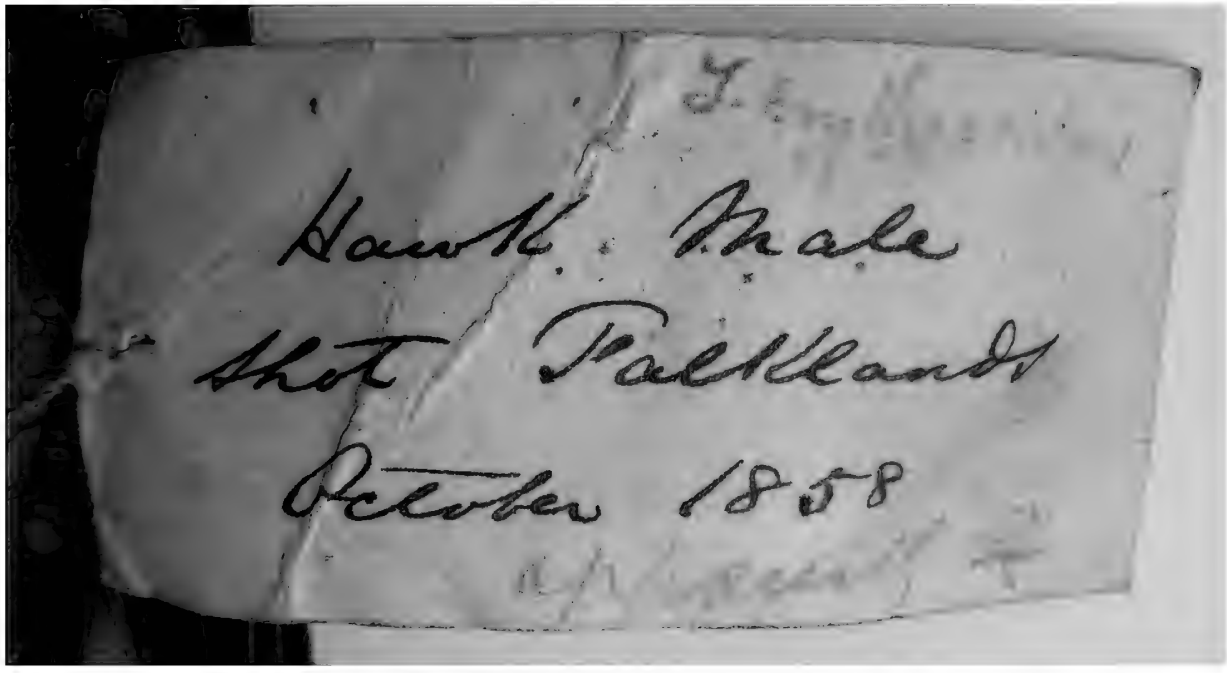

Fig. 4. Charles Compton Abbott label, back (Variable Hawk *Geranoaetus polyosoma*, NHMUK 1955.6-20.2413; photograph by Justin Jansen, 18 June 2015; © Natural History Museum, Tring, UK)

Schlegel 1862a (Tome II, 6: 12–13): *Buteo polyosoma*, Cat 3, male, habit de passage moins avance que celui du NO 2; roux rougeatre uniforme; iles Falkland, par Mr Frank.

Remark: Sexing is absent at the label, underside identifies ♂ as female, and Schlegel 1862d indetfies the bird as ♂. For information on the Amsterdam-based dealer Gustav Adolph Frank see: Kelp Goose RMNH.AVES.230433.

Variable Hawk *Geranoaetus polyosoma polyosoma* (Quoy & Gaimard, 1824) [RMNH.AVES.191231]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult ♂. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Schlegel 1862d.

Pedestal label: [one hand] *Buteo polyosoma* / m. Cat N°5 / pr. Mr. Frank / Falkland.

Pedestal underside: [two hands] 38 / *polyosoma* / *Buteo erythronotus* / King / jeune / Cat N°5 / pr. Frank / Malouines.

Schlegel 1862a (Tome II, 6: 12–13): *Buteo polyosoma*, Cat 5, ♂ au premier plumage, iles Falkland, par Mr. Frank.

Remark: The collection site on the label, underside and in Schlegel 1862d differ. Both the underside and label identify do not sex the bird, but Schlegel 1862d identifies it as an adult ♂. Only one name source is mentioned, King on the underside. For information on the Amsterdam-based dealer Gustav Adolph Frank see: Kelp Goose RMNH.AVES.230433.

Variable Hawk *Geranoaetus polyosoma polyosoma* (Quoy & Gaimard, 1824) [RMNH.AVES.191232]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1860 or 1861. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1862d; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Buteo polysoma* / m. Cat N°6 / voy. Cap. Abott / Falkland.

Pedestal underside: [two hands] 40 *polyosomoma* / ♂ / Cat N°6 / Reis van / cap. Abbot / Frank 1862 / Oost–Falkland.

Schlegel 1862a (Tome II, 6: 12–13): *Buteo polyosoma*, Cat 6, ♂ au premier plumage, iles Falkland, voyage du Capitaine Abbot.

Remark: The collection site on the label, underside and in Schlegel 1862d differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. Both the underside and Schlegel 1862d identify the specimen as male, but only the latter identifies it as an adult. For information on the Amsterdam-based dealer Gustav Adolph Frank see: Kelp Goose RMNH.AVES.230433. Note the difference in latin names on label and underside.

Falconidae

Striated Caracara *Phalcoboenus australis* J.F. Gmelin, 1788 [RMNH.AVES.193332]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: adult ♂. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Schlegel 1862b; Sclater 1860, 1861, 1862.

Pedestal Label: [one hand] *Polyborus australis*. / Cat N°1. / voy. Cap Abbot. Falkland.

Pedestal underside: [one hand] 43 / *Polyboris australis* / ♂ / Feet & bare parts of the head / bright yellow / Cat N°1 / reis van / Capt. Abbot / (Frank 1860) / Oost Falkland.

Schlegel 1862b (Tome II, 9: 3–4): *Polyborus australis*, Cat 1, ♂ au plumage parfait, ile orientale de Falkland, voyage du capitaine Abbot, obtenu en 1860.

Remark: The collection site on the label, underside and in Schlegel 1862b differ. The name Abbott was transcribed incorrectly at label, underside and in Schlegel. Both label as underside lack ageing, in Schlegel 1862b the bird is aged. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 as for C.C. Abbott). Only Schlegel's handwriting appears under the base of the pedestal.

Striated Caracara *Phalcoboenus australis* J.F. Gmelin, 1788 [RMNH.AVES.193333]. Loc: Falklands (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Col: voyage *La Coquille*, R.P. Lesson / P. Garnot. Date: November–December 1822. Age/sex: adult. Acq: received in exchange with the Paris Museum. Status: extant, accessed 11 February 2013. Tax: mounted. Pub: Lesson & Garnot 1826–1830; Schlegel 1862d.

Pedestal label: [one hand] *Polyboris australis*. / Cat N°2. / voy. de Coquille. Falkland.

Pedestal underside: [two hands] *Polyborus australis* / *Falco novae Zelandia* / Lath / 37. / Coquille Pl. / Cat. N° 2 / *Caracara funèbre*. / Temm.Pl.Col.192. / Ost-Falkland / ~~van Diemen~~ / Patagonia.

Schlegel 1862b (Tome II, 9: 3–4): *Polyborus australis*, Cat 2, Individue au plumage parfait, iles Falkland, voyage de *la Coquille*.

Remark: The collection site on the label, underside and in Schlegel 1862b differ. Both label as underside lack ageing, in Schlegel 1862b the bird is aged.

Striated Caracara *Phalcoboenus australis* J.F. Gmelin, 1788 [RMNH.AVES.193334]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: adult. Acq: via Gustav Adolph Frank Sr. Status: extant, accessed 11 February 2013. Tax: mounted. Publ: Schlegel 1862d.

Pedestal Label: [one hand] *Polyborus australis*. / Cat N°3. / pr. Mr. Frank. Falkland.

Pedestal underside: [one hand] 29 / *Polyborus australis* / *Falco novae Zeelandiae* Lath / *Caracara funebre* Tem / Pl.Col.192 / Cat N°3 / pr. Frank, ~~Malouines~~ / Falkland.

Schlegel 1862b (Tome II, 9: 3–4): *Polyborus australis*, Cat 3, Individue au premier plumage, iles Falkland, par Mr. Frank.

Remark: The collection site on the label, underside and in Schlegel 1862b differ. Both label as underside lack ageing, in Schlegel 1862b the bird is aged. For information on the Amsterdam-based dealer Gustav Adolph Frank see: Kelp Goose RMNH.AVES.230433. Two specimens are missing from HMS *Beagle* (Steinheimer 2004). Only Schlegel's handwriting appears under the base of the pedestal.

Furnariidae

Blackish Cinclodes *Cinclodes antarcticus* Garnot, 1826 [RMNH.AVES.168495]. Loc: East Falkland (*ca.*

51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: –. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Cinclodes antarcticus* (Garn.) / Voy. Capt. Abbot Stanley. East Falkland / 1860.

Pedestal underside: [one hand] Capt. / Abbot Stanley / 1860 / Oost Falkland.

Remark: The name giving of the location of collecting is different in underside and label. Only Schlegel's handwriting under the base of the pedestal. The name Abbott was transcribed incorrectly at the underside and label. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 above).

Troglodytidae

Grass Wren *Cistothorus platensis falklandicus* Chapman, 1934 [RMNH.AVES.168365]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: –. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Cistothorus platensis* (Lath.) / Frank, 1860 / East Falkland.

Pedestal underside: [one hand] Frank / 1860 / Oost-Falkland.

Remark: The collection site on the label and underside differ. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 above). Only Schlegel's handwriting appears under the base of the pedestal.

Turdidae

Austral Thrush *Turdus falcklandii falcklandii* Quoy & Gaimard, 1824 [RMNH.AVES.170710]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: before 1850. Col: –. Age/sex: –. Acq: –. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: –.

Pedestal label 1: [one hand] *Turdus falklandicus* Quoy & Gaimard / Avant 1850 / Falkland Isl.

Pedestal label 2: [two hands] *Turdus falklandicus* / Q et G. / Patria? / Falkland Isl.

Pedestal underside: [one hand] *Turdus falklandicus* / Quoy et Gaimard.

Remark: Handwriting is Temminck's and therefore an old specimen, most likely received in exchanges with the Parisian Museum. One specimen is missing from HMS *Beagle* (Steinheimer 2004).

Icteridae

Long-tailed Meadowlark *Leistes loyca falklandica* (Leverkühn, 1889) [RMNH.AVES.168495]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: –. Acq: via John Gould and Gustav Adolph Frank Sr. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Sclater 1860, 1861, 1862.

Pedestal label: [one hand] *Trupialis militaris* (L.) / Cat. / (Sclat. Ib. 1884: p. 23) / Acquis du Capt / Abbot Stanley 1860 / Falkland occ.

Pedestal underside: [two hands] *Trupialis militaris* (L.) / 3 / ♂ / Kapt. / Abbot Stanley / 1860 / Oost Falkland.

Remark: Only Schlegel's handwriting under the base of the pedestal. The name Abbott was transcribed incorrectly at label and in underside. The collection site on the label and underside differ. Sexing lacks at the label. The name Abbott was transcribed incorrectly at the underside and label. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433).

Emberizidae

White-bridled Finch *Melanodera melanodera melanodera* (Quoy & Gaimard, 1824) [RMNH.AVES.165592]. Loc: East Falkland (*ca.* 51° 41′ 40″ S, 57° 51′ 10″ W). Date: in either 1858 or 1859. Col: C.C. Abbott. Age/sex: ♀. Acquisition: via John Gould and Gustav Adolph Frank Sr. in 1860. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: Abbott 1860, 1861; Gould 1859; Sclater 1860, 1861, 1862.

Pedestal label: absent.

Pedestal underside: [one hand] ♀ / Capt / Abbot Stanley / 1860 / Oost Falkland.

Remark: The name Abbott was transcribed incorrectly at the underside. The bird was acquired through the Amsterdam-based dealer Gustav Adolph Frank and arrived on 30 April 1860 (see Kelp Goose RMNH.AVES.230433 above). Only Schlegel's handwriting appears under the base of the pedestal.

White-bridled Finch *Melanodera melanodera melanodera* (Quoy & Gaimard, 1824) [RMNH.AVES.165582]. Loc: Falkland (*ca.* 51° 41′ 0″ S, 59° 10′ 0″ W). Date: –. Col: –. Age/sex: ♂. Acq: –. Status: extant, accessed 18 December 2012. Tax: mounted. Pub: –.

Pedestal label: [one hand] *Chlorospiza* Gray / *Emberiza melandera* / Beagle pl 32. Uranie alt pl. / ♂ / Malouines.

Pedestal underside: no text.

Remark: Handwriting is Temminck's and therefore an old specimen, most likely received in exchanges with the Parisian Museum.

DISCUSSION

Original labels

I found no original labels on Falkland specimens from the French expeditions (both in Naturalis as in MNHN). However, the information (albeit only for some) is recorded in a number of books and papers in the MNHN archives; most of this information is also found on the pedestal underside, with a summary of the information from the pedestal underside being transcribed on the labels (where the information was first recorded – in the books and papers or under the pedestals – is uncertain). The Falkland specimens in the MNHN were apparently treated in the same manner as were earlier specimens from the Baudin expedition (389 specimens examined) (Jansen 2018), which also arrived in France as skins. Usually only single specimens, representing the male, female, and young (if present and recognisable) of each species collected on the Baudin expedition were kept, with duplicates used for exchanges and donations (Jansen 2016, 2018). When mounted, the known information was transcribed on the pedestal underside by the museum's taxidermists, as it was for the 25 Falkland specimens examined in the MNHN. The information found on the pedestal underside does not have either the original collector, the date of collection, or the specific collecting locality within the Falklands.

For the Falkland birds collected by the British expeditions, I found a number of specimens with original labels. Of 69 birds examined collected by McCormick on the *Erebus* and *Terror* expedition, 38 had an original label (some of McCormick's birds however are attributed to the Admiralty). Of 3 birds examined from the *Rattlesnake* expedition, only one had an original label; one of those without an original label was collected by MacGillivray. Of 15 birds examined from HMS *Beagle* (collected by Covington/Darwin and Fitzroy and donated by Burnett), none had original labels. However, most of Abbott's Falkland birds in the NHMUK still have their original labels attached: of 16 examined, only one did not have an original label or annotations from Abbott.

Original collector

We find on the labels attached to the Naturalis specimens the following data regarding sources, including collectors and expeditions: C.C. Abbott (46), Frank Merchants from Amsterdam (21), no data (11), *La Coquille* (5), *L'Astrolabe* (2), HMS *Beagle* (1), *L'Uranie* (1) and MNHN (1). Of these, 3 birds (two from *La Coquille* and one with no data) are not indisputably from the Falklands.

For 54 Naturalis birds (60%) – 46 birds collected by Abbott and 7 birds from the French expeditions and HMS *Beagle* – we can more or less determine the original collector and date of collection. Similar data for the remaining 35 Naturalis birds (40%), however, is not possible to reconstruct. Based on information from Abbott (Gould 1859, Abbott 1860, 1861) and data found in the journals of the French expeditions and HMS *Beagle*, we know the approximate period when collecting occurred (odd is that the HMS *Beagle* bird is the sole bird with a full date collecting date on it, and one of the very few birds in Naturalis collected prior to 1850 with such a dataset). However, precise data, including exact location, date of collection, and specific collector, is beyond the scope of this paper.

For the birds purchased from the Frank Merchants in Amsterdam, we find 21 birds in Naturalis that have Frank recorded as their source. Obviously, they were not the collectors of these specimens, as no bird was collected at all by the Frank family in the Falklands (there is no documented Falkland Islands visit from these Amsterdam based merchants).

Did the Naturalis archives provide any additional help? We only find notes in the Naturalis archives referring to Falkland birds received from Frank to the Rijksmuseum van Natuurlijke Historie (forerunner of Naturalis) from 3 May 1854 (*Procellaria*), 16 June 1856 and 30 April 1860. These notes typically describe the acquired specimens only vaguely.

Transcription errors and omissions

All birds in NHMUK from Abbott have recorded on their original labels the month and year when collected. Other details – in particular notations on bare parts – are also present on some of the Abbott labels in the NHMUK. However, older specimens (distinguished by having smaller labels attached, while specimens collected later have larger labels, with "Captain Abbott, Falkland Islands Detachments" printed on the reverse) note only the species, sex, and month of collecting (a portion of Abbott birds have the printed labels attached to them).

The 46 Abbott birds in Naturalis (51.6% of all (89) Falkland birds in Naturalis) once had original labels attached like those attached to the Abbott birds in the NHMUK. However, of these 46 Naturalis specimens, only 14 (29.8%) include some details on bare parts (all noted on the pedestal underside); the remainder (70.2%) lack such details. Of these 14 specimens, 8 have such notes transcribed in English, while in the remaining 6, the notes are translated into Dutch; the original contexts of the latter are therefore missing, and no notes in the original English can be traced. These notes are found only on the pedestal underside and not in any other of the available sources, such as Schlegel's publications, new tags, or pedestal labels. If we compare labels, pedestal undersides and Schlegel's various publications to each other, we find no consistency in either the way Abbott was addressed (e.g. either as "Mr." or "Captain", "Cat.", "Cap.", "Capt." and variations) or how his name was

spelled (e.g. "Abbot", "Abbott", and "Abott"); moreover, "voyage" or "Voy." (e.g. "voyage du Capitaine Abbot" and "Voy. Cap. Abbot"), "Stanley" (e.g. "Abbot Stanley", "Cat. Abbot Stanley", "Voy: Abbot Stanly" and "Voy. Abbot Stanley"), and "col" (e.g. "Abbot col") were also recorded. Neither the month or year when each specimen was collected / arrived is recorded on any of the 46 Abbott birds in Naturalis, as they are on all of the NHMUK specimens.

CONCLUSIONS

Coenraad Jacob Temminck and Hermann Schlegel, both collection managers of birds at the Rijksmuseum van Natuurlijke Historie (now Naturalis), discarded all the original labels at the time when original information and precise data was not appreciated or as valued as it is today (Steinheimer 2010); moreover, the data that was available was imprecise and treated poorly, with the information not being transcribed precisely and suffering alteration over time. However, as shown in results, the damage can be controlled for a large number of specimens by analysis of the available original material and interpretation of the information supplied by various sources.

Further research into diaries, letters and acquisition books and the actual specimens should be considered in the future to establish the correct labeling of the specimens (for example to sort out the possible mix-up from *L'Uranie* and *La Coquille* specimens). Also, the condition (looks fair to good in most specimens) of the mounts / skins can be examined as they could be subject to x-radiation (Jansen & Steinheimer 2017).

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REFERENCES

Abbott CC (1861) Notes on the Birds of the Falkland Islands. Ibis (3): 149–167

Abbott CC (1860) The Penguins of the Falkland Islands. Ibis (2): 336–338

Darwin CR (1839) Narrative of the surveying voyages of His Majesty's Ships Adventure and Beagle between the years 1826 and 1836, describing their examination of the southern shores of South America, and the Beagle's circumnavigation of the globe. Journal and remarks 1832–1836. John Murray, London

Darwin CR (1859) On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life. John Murray, London

Darwin CR (1871) The Descent of Man, and Selection in Relation to Sex. John Murray, London

de Freycinet LCD (ed.) 1824 Voyage autour du monde: entrepris par ordre du roi ... exécuté sur les corvettes de S. M. l'Uranie et la Physicienne, pendant les années 1817, 1818, 1819 et 1820. Chez Pillet, Paris

de Freycinet LCD (ed.) (1837) Voyage autour du Monde... exécuté sur les corvettes de L. M. «l'Uranie» et «La Physicienne,» pendant les années 1817, 1818, 1819 et 1820. Paris

Gould J (1839) Part 3 (2): Birds. Pp. 17–32, pls. 11–20. In: Darwin C. (ed.) The zoology of the Voyage of H.M.S. Beagle, under the command of Capt. Fitzroy, R.N., during the years 1832 to 1836, part 6. London

Gould J (1859) List of Birds from the Falklands, with Descriptions of the Eggs of some of the species, from specimens collected principally by Captain C. C. Abbott, of the Falkland Islands Detachment. Proceedings of the Zoological Society of London 27: 93–98

van Grouw H, Steinheimer FD (2008) Charles Darwin's lost Cinereous Harrier found in the collection of the National Museum of Natural History Leiden. Zoologische Mededelingen Leiden 82 (48): 595–598

del Hoyo J, Collar NJ (2014) HBW and Birdlife International Illustrated Checklist of the Birds of the World. Volume 1: Non-Passerines. Lynx Edicions, Barcelona

del Hoyo J, Collar NJ (2016) HBW and Birdlife International Illustrated Checklist of the Birds of the World. Volume 2: Passerines. Lynx Edicions, Barcelona

Jansen JJFJ (2016) Towards the resolution of long-standing issues regarding the birds collected during the Baudin expedition to Australia and Timor (1800–1804): the discrepancy in the number of birds collected and their subsequent handling. Journal of the National Museum (Prague). Natural History Series 185 (2): 7–19

Jansen JJFJ (2018) The Ornithology of the Baudin expedition (1800–1804). Privately published, Grave

Jansen JJFJ, van der Mije SD (2015) Review of the mounted skins and skulls of the extinct Falkland Islands wolf, *Dusicyon australis*, held in museum collections. Archives of Natural History 42 (1): 91–100

Jansen JJFJ, Steinheimer FD (2017) Research into the authenticity of 'I'iwi *Drepanis coccinea* (G. Forster, 1781) skins from Cook's 3rd voyage: what taxidermy can add to the discussion. Bulletin of the British Ornithologists' Club 137 (4): 246–260

Lanjouw J, Stafleu FA (1954) Index herbariorum; a guide to the location and contents of the world's public herbaria; Pt. II, 1; Collectors A-D. International Bureau for Plant Taxonomy and Nomenclature of the International Association for Plant Taxonomy, Utrecht

Lesson RP, Garnot P (1826–1830) Voyage autour du monde entrepris par ordre du government sur la corvette la Coquille pendant les années 1822, 1823, 1824 et 1825. Paris

MacGillivray W (1852) Narrative of the voyage of H.M.S. Rattlesnake, commanded by the late Captain Owen Stanley during the years 1846–50, including discoveries and surveys in New Guinea, the Louisiade Archipelago, etc: to which is added Mr. E.B. Kennedy's expedition for the exploration of the Cape York Peninsula. London

Mees GF (1953) The white-eyes of the Aroe Islands (Aves, Zostreopidae). Zoolgische Mededelingen 32 (2): 25–30

Mees GF, Fisher CT (1986) On the type specimens of birds from Lifu, described by E. L. Layard in 1878. Bulletin of the British Ornithologists' Club 106: 153–156

Rasmussen PC, Prŷs-Jones RP (2003) History *vs* mystery: the reliability of museum specimen data. Bulletin of the British Ornithologists' Club 123: 66–94
Schlegel H (1862a) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome II. 6: Buteones– August 1862. E.J. Brill, Leiden
Schlegel H (1862b) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome II. 9: Polybori – November 1862. E.J. Brill, Leiden
Schlegel H (1862c) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome II. 10: Vultures – November 1862. E.J. Brill, Leiden
Schlegel H (1862d) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome II. 13: Circi – December 1862. E.J. Brill, Leiden
Schlegel H (1863a) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome VI. 21: Pelecani – July 1863. E.J. Brill, Leiden
Schlegel H (1863b) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome VI. 22: Procellaridae – July 1863. E.J. Brill, Leiden
Schlegel H (1863c) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome VI. 32: Lari – August 1863. E.J. Brill, Leiden
Schlegel H (1863d) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome VI. 24: Sternae – September 1863. E.J. Brill, Leiden
Schlegel H (1864) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome V. 27: Scolopaces – November 1864. E.J. Brill, Leiden
Schlegel H (1865) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome IV. 29: Cursores – March 1865. E.J. Brill, Leiden
Schlegel H (1866) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome VI. 31: Anseres – May 1866. E.J. Brill, Leiden
Schlegel H (1867) Muséum d'Histoire naturelle des Pays-Bas. – Revue méthodique et critique des collections déposées dans cet établissement. Tome VI. 33: Utrinatores – April 1867. E.J. Brill, Leiden
Sclater PL (1860) Catalogue of the. Birds of the Falkland Islands. Proceedings of the Zoological Society of London 28: 382–391
Sclater PL (1861) Additions and Corrections to the list of the Birds of Falkland Islands. Proceedings of the Zoological Society of London 29: 45–47
Sclater PL (1862) Catalogue of a collection of American birds. N. Trubner and Co., London
Sharpe RB (1906) The history of the collections contained in the natural history departments of the British Museum. Birds. Trustees of the British Museum, London
Steinheimer FD (2004) Charles Darwin's bird collection and ornithological knowledge during the voyage of H.M.S. Beagle, 1831–1836. Journal of Ornithology 145: 300–320
Steinheimer FD (2010) Data-basing historical specimens – a science of its own. proceedings of the 5th International Meeting of European Bird Curators: Natural History Museum Vienna, August 29th–31st, 2007, Vienna, Austria: 113–119

APPENDIX I

Birds as noted as collected on the Falklands on *L'Uranie* from the lists of specimens that arrived in the MNHN (archives Laboratory MNHN, October 1820, unknown ammount arrived in 1821, Freycinet (also indicated as Quoy & Gaimard))

'goose' *Chloephaga* 6, Chiloe Wigeon 3, "ducks" 3, 'grebe' 2+4, 'heron' 4, 'pigeon' 4, 'rail' 1, King Penguin 1, 'penguin' *Eudyptes* 1, 'penguin' 1, 'albatros' 3, 'petrel' 3, Magellanic Cormorant 6, Snowy Sheatbill 1, South American Snipe 1, Kelp Gull 1, 'tern' 4, Turkey Vulture 4, Cinereous Harrier 2, Variable Hawk 2, Caracara 1, Blackish Cinclodes 4, Austral Thrush 7, Long-tailed Meadowlark 1–2, White-bridled Finch 1.

Obviously the 'pigeons' are a mistake, as they don't occur on the Falklands (therefore the number is corrected from 69 to 65).

Still present in MNHN (verified through a quick check) Upland Goose 2, Mallard 1, Crested Duck 1, Yellow-billed Teal 2, White-tufted Grebe 3, Common Diving-petrel *Pelecanoides urinatrix* 1, Rock Shag 3, South American Snipe 2, Brown Skua *Stercorarius antarcticus* 2, Black-crowned Night-heron 2, Sterna *ssp* 1, Turkey Vulture, Cinereous Harrier 2, Variable Hawk 1, Striated Caracara 4, Austral Thrush 1, White-bridled Finch 2.

APPENDIX II

Birds as noted as collected on the Falkland on *La Coquille* from the lists of specimens that arrived in the MNHN (archives Laboratory MNHN, April 1825, Garnot & Lesson)

Variable Hawk 5, Austral Thrush 1, Cinclodes 2, Plover 3, Oystercatcher 2, Grebe 2, Petrel 1, Skua 2, Cormorant 1, Goose 1, Duck 4.

Still present in MNHN (verified through a quick check) Kelp Goose 2, Falkland Steamer Duck 1, Southern Silvery Grebe 1, Rock Shag 2, Snowy Sheatbill 1, Magellanic Oystercatcher 1, Southern Lapwing 2, Striated Caracara 1, Austral Thrush 1.

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Azara's spinetails (Aves: Furnariidae). The identity of No. 236 Chiclí and No. 237 Cógogo

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Abstract. The descriptions of birds provided by Félix de Azara (1742–1821) from his time in Paraguay constituted some of the first and most detailed descriptions of the South American avifauna from the period. Whilst many formed the basis for scientific names still in use today, others have remained inconclusively identified. In this paper the identities of two of these descriptions referring to spinetails of the genus *Synallaxis* are elucidated. There has been considerable disagreement amongst previous authors as to the correct identity of two of these descriptions. No. 236 Chiclí is shown to refer to Sooty-fronted Spinetail *Synallaxis frontalis* and No. 237 Cógogo to Pale-breasted Spinetail *S. albescens*.

Key words. Pale-breasted Spinetail, Sooty-fronted Spinetail, *Synallaxis frontalis*, *Synallaxis albescens*.

The ornithological magnum opus "Apuntamientos para la historia natural de los páxaros del Paraguay y Río de la Plata" (1802–1805) by the Spanish military engineer Félix de Azara (1742–1821) was one of the first serious attempts to document the avifauna of the Southern Cone of South America produced by a researcher living in the study area. Based in Asunción, Paraguay, Azara was a meticulous student of the fauna, geography and culture of the land he now called home, a broad area he called "Paraguay and La Plata", which includes modern day eastern Argentina, Paraguay, extreme southern Brazil and Uruguay. Working in close conjunction with the Jesuit priest Padre Nóseda, who resided in the town of San Ignacio, Misiones department, he produced simple, but highly detailed descriptions of 448 different "species", over half of which were unknown to science at that time. A detailed chronology of his movements, life and work is provided by Contreras (2010).

Despite over two centuries having passed since the publication of Azara's work, not all of Azara's descriptions have been conclusively associated with known species and a series of authors have attempted to identify and apply them to known taxa (Sonnini in Azara 1809; Hartlaub 1847; Burmeister 1861; von Berlepsch 1887; Bertoni 1901; Laubmann 1939; Pereyra 1945; Smith 2018; Smith et al. 2018). Despite this some species remain unidentified, whilst others have been the subject of disagreement between authors. In this paper I provide identifications for two of Azara's spinetails for which there has been no previous consensus in the literature. Note that Azara's measurements are given in inches (= 25.4 mm), lines (= 2.21 mm) and varas (= 83.6 cm).

No. 236 CHICLÍ (Azara Volume 2: 266)

"*Le doy este nombre, porque lo canta con claridad en tono alto y agudo, oyéndose de muy léjos, y repitiéndolo de modo, que las pausas no duran mas que los cantares. No dudo que la hembra es silenciosa, y que no difiere del macho; pues seguramente he visto y tenido cien individuos idénticos, todos en el Paraguay. Es estacionario y solitario sin abundar. Habita entre los caraguatas ó aloes y matorrales espesos, sin subir jamas á dos varas de altura, ni dexarse ver á descubierto. Está en movimiento continuo, sin salír á los campos, ni internarse en bosques grandes, y sin duda come arañas é insectos. Sus vuelos se reducen á pasar de un matorral á otro inmediato: y aunque no conoce esquivez, es difícil verle en sus guaridas, y al oírle se figurará el que no lo conozca que está en lo alto del árbol ó matorral, quando se halla al pie entre la ramazón ó caraguatás.*

Longitud 6 ¼ pulgadas: cola 3: braza 7. El angosto tupé es pardo, y sobre la cabeza, el encuentro, cobijas y cola, de un bermellón algo obscurecido en la cola. De esta al cogote pardo acanelado, y los remos como la cola. Baxo de la cabeza hay una mancha de plumas negras, con las puntas casi blancas, que tapan lo negro quando están bien ordenadas. De alli al pecho pardo blanquizco, como la ceja y el costado de la cabeza. Baxo el cuerpo

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mas blanquizco : sus costados como el lomo, pero mas claros; y las tapadas de canela clara y linda.

Remos 19, cóncavos y endebles, el quarto mayor: la cola 10 plumas agudas, débiles y en escalera: la de afuera 24 lineas mas corta: pierna 13: tarso 10, verdoso aplomado: dedo medio 6 ½ : pico 5, muy comprimido por los costados, recto con la puntita poco corva, que excede á la mitad inferior, obscuro encima, blanquizco debaxo, y el iris color de caña roxiza."

(*My translation*)

"*I give it this name because it sings it with clarity in a high and sharp tone, being audible from far away, and repeating it in a way that the pauses between notes are of lesser duration than the notes themselves. I don't doubt that the female is silent, and doesn't differ from the male; in fact I have surely seen and had hundreds of identical individuals, all in Paraguay. It is resident and solitary, but not abundant. It lives amongst the bromeliads or aloes, and in dense scrub, without ever rising to a height of more than 1.67 metres, nor does it let itself be seen in the open. It is continuously on the move, without ever coming out into the fields or entering the great forests, and without a doubt it eats spiders and insects. Its flight is reduced to passing from one patch of scrub to the next: and although it isn't shy, it is difficult to see it in its haunts, and upon hearing it the inexperienced observer will think that it is high in the tree or scrub, when in fact it is at the base amongst the bushes and bromeliads.*

Length 158.8 mm: tail 76.2 mm: wing span 177.8 mm. The thin forehead is grey, and the top of the head, the wing bend, coverts and tail are bright reddish, slightly darker on the tail. From the forehead to the nape brownish-cinnamon, and the flight feathers like the tail. Under the head there is a spot of black feathers with the tips white, which cover the black when they are well ordered. From there to the breast brownish-grey, as with the supercilium and sides of the head. Under the body more greyish : the sides as the back, but paler; the underwing an attractive pale cinnamon.

Flight feathers 19, concave and weak, the fourth is longest: the tail with 10 sharp, weak feathers, increasing in size towards the centre pair: the outermost 53 mm shorter: leg 28.7 mm: tarsus 22.1 mm, greenish-grey: mid-toe 14.4 mm: bill 11.1 mm, very compressed at the sides, straight with a slightly hooked tip, that is longer than the lower mandible, dark grey above, pale grey below, with the iris the color of red rum."

Associated with *Synallaxis ruficapilla* Vieillot, 1819 by Hartlaub (1847) and Burmeister (1861), *Synallaxis frontalis frontalis* von Pelzeln, 1859 by Bertoni (1901) and Laubmann (1939) and *Synallaxis albescens albescens* Temminck, 1823 by Pereyra (1945). The description of the voice, habits, measurements, forehead and tail colour indeed identify it as Sooty-fronted Spinetail *Synallaxis frontalis* von Pelzeln, 1859, a species that is abundant and widespread in Paraguay (Guyra Paraguay 2005).

Though Pereyra (1945) noticed that the measurements and throat colour were more consistent with *S. frontalis*, he seems to have erred when he stated that the voice indicated *S. albescens*. Apparently unfamiliar with the species in the field and unduly convinced by the similarity of Azara's call description to the common Argentinian name Pujiuí or Chicli that he attributed to this species (today the former being a generic name for any *Synallaxis* spinetail in Argentina) he opted for *S. albescens*. In fact Azara´s name *Chiclí* (which is based on the call note) is a near perfect rendition of that of *S. frontalis*, and quite unlike the typical *wee-bidget* call given by Paraguayan *S. albescens*.

No. 237 CÓGOGO (Azara Volume 2: 268)

"*Noseda y yo encontramos bastantes por septiembre y octubre en las cercanías del pueblo de S. Ignacio guazú del Paraguay; y observamos, que aunque iban solos, las hembras no estaban léjos, ni diferian en medidas y colores. El canto, peculiar del macho, no es brillante, pero puede pasar entre los adocenados, aunque tiene poca variedad, y lo repite con mucha frequencia. Habita los matorralitos, mantillas y pillas de leña de los campos, sin internar en los bosques grandes, ni subir á las mantillas altas y aparentes; y desde el momento que se posa empieza á corretear lo interior y mas baxo de la escoba ó matorrañito, prefiriendo al parecer los secarrones y que tienen al pies mas broza que verdura. Tanto por su continua inquietud, como por el cuidado con que se esconde huyendo del lugar ó costado donde le puedan ver, es muy dificil matarlo. Sus vuelos son por lo comun cortos ; pero á veces los prolonga para buscar matorrales lejanos, con mayor velocidad de la que parece compete á sus alas. Vive de los insectos que pilla en dichos matorralitos y entre el pasto muy alto y cerrado. Le llamo Cógogo, porque me aseguran que asi canta en tiempo que no es de amor, con la gravedad y fuerza que un páxaro grande; pero no salgo fiador de que esto sea verdad.*

Longitud 5 ⅔ pulgadas : cola 2 ¹¹/₁₂, braza 6 ½. Viendo que este páxaro no diferia del anterior, maté á un Chicli y á un Cógogo en el mismo dia para compararlos, buscando á uno y otro en sus respectivos domicilios, dirigiéndome por su voz, á fin de evitar toda equivocacion. Los exâminé con todo mi cuidado, y hallé que las formas del todo y de cada una de las partes eran absolutamente idénticas, sin que la mayor perspicacia pudiese notar, sino que el Chiclí tiene el ala ménos tendida. Por lo que hace á colores y el lugar que ocupan, son identicos, sin exceptuar los del pico, iris y tarso, pues aunque con la mayor atencion se nota que el Cógogo no tiene tan en-

Table 1. Mean and range measurements of Azara's descriptions compared with morphometrics of mist-netted individuals of the two proposed species (P. Smith unpublished data). *Synallaxis albescens* three individuals from Encarnación, Itapúa department (October 2005), Laguna Blanca, San Pedro department (November 2005) and Parque Nacional Teniente Enciso, Boquerón department (July 2006); *Synallaxis frontalis* four individuals from Encarnación, Itapúa department (August and October 2005).

	No. 237 Cógogo	*Synallaxis albescens* (n=3)	No. 236 Chiclí	*Synallaxis frontalis* (n=4)
Total Length	143.8	151 (148–159)	158.8	156.1 (155–157)
Tail	74.1	72.8 (67–77.5)	76.2	76.4 (75–78.5)
Wingspan	165.1	NA	177.8	NA
Leg	NA	NA	28.7	NA
Tarsus	NA	19.3 (18–20)	22.1	23.6 (23–25)
Middle Toe	NA	13.7 (12–16.5)	14.4	14.1 (13–15)
Bill	NA	10.5 (10–11)	11.1	12.4 (11.5–13)

cendida la cola, sobre la cabeza, y cobijas; y que el color sobre el cuerpo es poquito ménos acanelado, y por debaxo algo mas blanquizco: estas diferencia son tan pequeñas que caben sobradamente en la misma especie, y solo se advierten en el cotejo inmediato, sin poderse expresar con palabras; de modo que pueden decirse nulas, y que es imposible distinguir los páxaros por otros caracteres que la voz y costumbres; pues aunque la magnitud sea algo diferente, es tan corta cosa, que cabe en la propria especie, y aun en el modo de medir.

Remos 19, poco cóncavos, no muy débiles, el primero bastante corto, y el tercero, quarto y quinto iguales: cola 10 plumas en todo como la del Chiclí, y en ámbos *la central agudísima, las demas no tanto: el resto como en el anterior."*

(*My translation*)

"*Noseda and I found many during September and October close to the town of San Ignacio Guazú in Paraguay; and we observed that, although they went alone, the females were not far away, and they didn't differ in form or colour. The song, unique to the male, is not brilliant, but can pass as mediocre, although it shows little variety and is repeated frequently. It inhabits scrub, bushes and wood piles in the fields, without entering the great forests, nor climbing the tallest most conspicuous bushes ; and from the moment it lands it begins to hop around the interior and lowest bush, preferring it would seem the drier parts and with the base more brushy than leafy. It is extremely difficult to kill, as much for its constant restlessness as for the care it takes to hide itself by fleeing from the place it can be seen. Its flights are typically short ; but occasionally they are prolonged to find more distant patches of scrub, with greater speed than it seems from how it beats its wings. It lives on insects that it finds in the aforementioned scrub and amongst the high, dense grass. I call it Cógogo, because they assure me that this is how it sings outside of the reproductive season, with the gravity and strength of a large bird; but I cannot personally vouch for this being true.*

Length 143.8 mm : tail 74.1 mm, wing span 165.1 mm. Seeing that this bird did not differ from the previous species, I killed a Chicli and a Cógogo on the same day to compare them, looking for each one in their respective haunts, being guided by the voice so to avoid mistakes. I examined them with all my care, and found that the structure of both was absolutely identical, and with only the most careful attention was it noticeable that the Chiclí has the wing less elongated. In terms of colour and the parts of the body where they occur, they are identical, except for the bill, iris and tarsus, and with the greatest of attention it can be noted that the Cógogo does not have the colour of the tail, top of the head and coverts so brightly coloured; and that the colour of the upperparts is a little less cinnamon, and below it is somewhat paler : these differences are so slight that they fit within the variation of a single species, and they are only obvious in direct comparison, without being able to express them in words; to the point where it could be said they are non-existent and that it impossible to distinguish the species by characters other than the voice and their behaviour; you see although the size is somewhat different, it is so minor a difference that it is consistent with the same species, and even with the method of measurement.

Flight feathers 19, slightly concave, not very weak, the first very short, and the third, fourth and fifth equal: tail 10 feathers, as in the Chiclí, and in both the central feathers are very sharp, the others not so much: the rest is as for the previous species."

The identity of this form has been much debated, with Sonnini in Azara (1809) stating that it was a hitherto unknown species, Hartlaub (1847) noting only that the bird was not mentioned by Vieillot, Burmeister (1861) associating the description with *Synallaxis fulginiceps*

(= *Leptasthenura fulginiceps* d'Orbigny & Lafresnaye, 1837 which does not occur in Paraguay), von Berlepsch (1887) and Bertoni (1901) identifying it only so far as *Synallaxis* sp., Laubmann (1939) preferring not to offer an identification and Pereyra (1945) opting for *Synallaxis frontalis frontalis* von Pelzeln, 1859.

Azara notes that with Padre Nóseda they found "several during September and October close to the town of San Ignacio Guazú" (Misiones department). He describes this species as extremely similar to the "Chiclí", differing in voice, habitat, paler underparts, slightly smaller size (Tab. 1) and less "cinnamon" upperparts including the tail, crown and coverts which are less "brightly-coloured." These differences are clear enough to identify this bird as Pale-breasted Spinetail *Synallaxis albescens* Temminck, 1823 in that area of Paraguay, where it occurs sympatrically with *S. frontalis* the only other species with which it may be confused (Guyra Paraguay 2005, Narosky & Yzurieta 2006).

Azara states that he uses the name Cógogo because he has been assured that this is how the bird sings in the non-breeding season "with the gravity and strength of a large bird". However he clarifies that he cannot vouch for the veracity of that statement, indicating that he never heard the bird produce such a call. The description of the call is possibly due to confusion by locals with Chotoy Spinetail *Schoeniophylax phryganophila* Vieillot, 1817, a superficially similar bird that occurs in the same areas and habitats, and with a call that may be rendered in such a way. Regardless Azara's admission that the information is secondhand and the fact that no Paraguayan *Synallaxis* is known to change its call during the non-breeding season is enough to discard it from consideration.

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REFERENCES

Azara F de (1805) Apuntamientos para la Historia Natural de los Páxaros del Paraguay y Río de la Plata. Tomo 2. Imprenta de la Viuda de Barra, Madrid, Spain

Azara F de (1809) Voyages dans l'Amérique Méridionale. Oiseaux. Vol. 3. Dentu, Paris, France

Berlepsch H von (1887) Appendix. Systematisches Verzeichniss in der Republik Paraguay bisher beobachteten Vogelarten. Journal für Ornithologie 35: 113–134

Bertoni A de W (1901) Aves nuevas del Paraguay. Continuación a Azara. Anales Científicos Paraguayos 1: 1–216

Burmeister H (1861) Reise durch die La Plata-Staaten mit besonderer Rücksicht auf die physische Beschaffenheit und den Culturzustand der Argentinischen Republik, Zweiter Band. HW Schmidt, Halle

Contreras JR (2010) Félix de Azara. Su Vida y su Época. Tomo 2. Calidad Gráfica, Zaragoza, Spain

Guyra Paraguay (2005) Atlas de las aves de Paraguay. Guyra Paraguay, Asunción, Paraguay

Hartlaub CJG (1847) Systematischer Index zu Don Félix du Azara´s Apuntamientos para la Historia Natural de los Páxaros del Paraguay y Río de la Plata. Schünemann, Bremen

Laubmann A (1939) Die Vögel von Paraguay. Band 1. Strecker und Schröder Verlag, Stuttgart

Narosky T, Yzurieta D (2006) Guía para la identificación de las aves de Paraguay. Vazquez Mazzini, Buenos Aires

Pelzeln A von (1859) Über neue Arten der Gattungen *Synallaxis*, *Anabates* und *Xenops* in der kaiserlichen ornithologischen Sammlung, nebst Auszügen aus Johann Natterer's nachgelassenen Notizen über die von ihm in Brasilien gesammelten Arten der Subfamilien: Furnarinae und Synallaxinae. Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftlichen Classe 34: 99–134

Pereyra JA (1945) La obra ornitológica de Don Félix de Azara. Biblioteca Americana, Buenos Aires

Smith P, Pacheco JF, Bencke GA, Aleixo A (2018). Senior synonyms for three Neotropical birds described by Vieillot based on Azara (Passeriformes: Thraupidae, Tyrannidae, Tityridae). Zootaxa 4433: 141–150. https://doi.org/10.11646/zootaxa.4433.1.8

Smith P (2018). The identity of *Sylvia ruficollis* Vieillot, 1817 and Azara's No. 240 "Cola aguda cola de canela obscura" (Aves; Furnariidae). Ardea 106: 79–83

Temminck CJ (1823) Nouveau recueil de planches coloriées d'oiseaux, pour servir de suite et de complément aux planches enluminées de Buffon. Dufour & d'Ocagne, París, France

Vieillot LP (1817) Nouveau dictionnaire d'histoire naturells, appliquée aux arts, à l'agriculture, à l'économie rurale et domestique, à la médicine, etc. par una société de naturalistes et d'agriculteurs. Nouvelle édition. Tome 7. Deterville, Paris, France

Vieillot LP (1819) Nouveau dictionnaire d'histoire naturells, appliquée aux arts, à l'agriculture, à l'économie rurale et domestique, à la médicine, etc. par una société de naturalistes et d'agriculteurs. Nouvelle édition. Tome 32. Deterville, Paris, France